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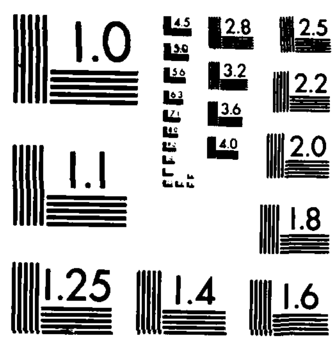

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COMPARISON OF CENTRALIZED-MANUAL, CENTRALIZED-COMPUTERIZED, AND DECENTRALIZED-COMPUTERIZED ORDER AND MANAGEMENT INFORMATION MODELS FOR THE TURKISH AIR FORCE LOGISTICS SYSTEM

THESIS

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AFIT/GLM/LSM/86S

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THESIS

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

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Master of Science in Logistics Management

A. Aydin Yilmaz, B.S.

First Lieutenant, TUAF

September 1986

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Abstract

thesis
This ~~study~~ investigates three base-level logistics order and information models to show their effects on logistics system performance. The selected models are the current TUAF manual system, the planned TUAF RDS and the current USAF COMO/COSO order and information models. The first two models represent a centralized logistics mangement policy. The third model, USAF's COMO/COSO, represents a more decentralized logistics management policy using a computerized order and information procedure. To compare the performance of these three models, the TSAR (Theater Simulation of Airbase Resources) program was used. Input data was obtained from an F-16 TSAR Data Base documented by Orlando Technology, Inc. of Orlando Florida. Outputs of the three models are analyzed by comparing the flown sortie rate, number of non mission capable (NMC) aircraft, NMC hours, and number of holes for a given scheduled sortie rate, stock level, and number of aircraft.

The results of this study indicate that the USAF COMO/COSO order and information model policy gives the highest flown sortie rate. It also provides the highest number of NMC aircraft and holes, and NMC hours for given

order and ship time. However, the lowest NMC hours per hole resulted from this model. The results also indicated that the TUAF manual order and information model is the least desirable because it provides the lowest sortie rate. It also yields the lowest number of NMC aircraft, and holes, and NMC hours for given order and ship time. However, it provides the highest NMC hours per hole.

The major limitations of this study are: (1) Approximated order and ship times, (2) Hypothetical information about the TUAF Logistics policy, procedures, and organizational functions.

This study should only be used as a reference for a further study that utilizes real data, and as a convenient reference for discussion of logistics system's base-level order and management information policies.

COMPARISON OF CENTRALIZED-MANUAL, CENTRALIZED-COMPUTERIZED, AND DECENTRALIZED-COMPUTERIZED ORDER AND MANAGEMENT INFORMATION MODELS FOR THE TURKISH AIR FORCE LOGISTICS SYSTEM

I. Introduction

General Issue

Like any large complex organization, the Turkish Air Force (TUAF) Logistics System (established in the 1950's and not updated since the 1960's) has many shortfalls. The Reorganization and Mobilization II (REMO II) program was adopted by the TUAF in 1981 to address percieved shortfalls and update the TUAF Logistics System. According to REMO II Projesi Reorganizasyon Brifing Dokumani (Briefing Documentation of REMO II project), the reasons for developing a new logistics system are summarized below (14:2):

a. The logistics system did not have the capability to support newly acquired weapon systems.

b. Accurate and fast logistics information flow were not provided to support the commander's/manager's decisions.

c. Sufficient information interface in the logistics area, especially in Foreign Military Sales (FMS), was not available.

d. The logistics budget was not prepared realistically because of insufficient data and information.

e. Demand factors used for forecasting, were not current.

f. Sufficient cataloging and stock numbering were not provided.

g. Logistics training did not meet changing requirements.

As one of the long range objectives of REMO II, the Requirements and Distribution System (RDS) has been developed to improve the communication between maintenance and supply, and to improve information system capabilities at the base and depot levels (Appendix B). As a short range objective of the RDS program, the TUAF depots and the Logistics Division of TUAF Headquarters have obtained a computer system which will assist in the command and control of their wholesale logistics responsibilities. Central visibility and control of supply units will be accomplished by using a central host computer at the TUAF Logistics Command Headquarters. Access to the host computer will be available from both base and depot levels. (4:1) In mid-1987, operational base, depot and headquarters levels of the TUAF Logistics System will begin to execute their functions with the computer communication system (Appendix B).

Specific Problem

The system proposed under RDS will be evaluated on its ability to manage logistics system's data bases, improve data base' reliability, improve aircraft readiness rates, and reduce ordering time (see Appendix B). However, the performance of the TUAF logistics system's order and management information models (current and RDS) have not been estimated analytically. All diagnostics and recommendations about both systems are based on an intuitive approach. Prior to this effort, there has not been a practical study to show the performance differentiation between the systems.

This study will investigate an appropriate Order Processing and Management Information System (OP&MIS) to link base-level supply and maintenance organizations by comparing the current TUAF Logistics System's manual, the future RDS (computerized and centralized), and USAF COMO/COSO (Combat Oriented Maintenance Organization / Combat Oriented Supply Organization) order and management information models.

Research Objectives

The main purpose of this research is to evaluate alternative OP&MIS models as measured by sortie rates and various secondary measures. It compares USAF and TUAF policies and procedures for identification and delivery of aircraft spares to the flightline.

Investigative Areas

The study used following methodology:

1. Reviewed the current order processing and information model of the TUAF Logistics System. (centralized-manual model)
2. Described the RDS program's order processing and information system. (centralized-computerized model)
3. Described the order processing and information system of the USAF F-16 base COMO/COSO organization. (decentralized-computerized model)
4. Compared these three order processing and information systems.
5. Suggests an appropriate order and information model for the TUAF Logistics System.
6. Clarifies the necessity and importance of the new system and its contribution to the REMO II program.

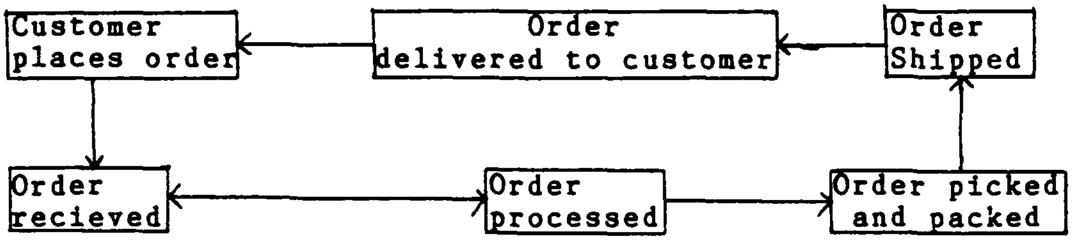
Research Justifications

Like any air force logistics system, the TUAF Logistics System's aim is to maximize the flown sortie and aircraft readiness rate (mission capable rate). Maximum flown sortie and aircraft readiness are achieved "by having the right things, in the right quantities, at the right time, and at the right place" (11:11). To achieve the above objectives effectively and efficiently, "all of the logistics principles must be applied together" (2:4-20). Information and communication are considered important factors, as "The capability of the logistics system to adapt to changes increases as information to support decision-making increases. . . The quality of information received for decision making is a function of its accuracy, timeliness, relevance, conciseness, objectivity, completeness, quantifiability, and clarity." (2:4-16)

Operational supply activities begin when an order occurs. Therefore, an order processing system is the nerve center of the supply component of the logistics system. "Theoretically, a typical order cycle consists of the following components: (1) order preparation and transmittal, (2) order receipt and order entry, (3) order processing, (4) warehouse picking and packing, (5) order transportation, and (6) customer delivery and unloading" (see Figure-1) (11:307).

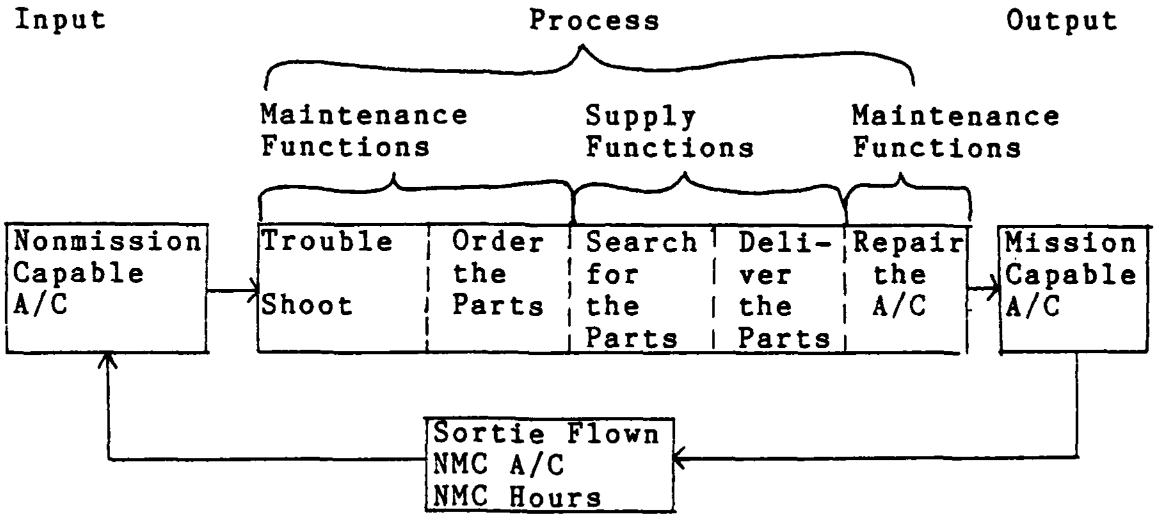
Figure 2 shows how this theorical explanation can be applied to a base-level logistics system. Input to the system is non-mission capable aircraft (A/C). Identification of the failed part (trouble shooting), ordering and restoration functions are accomplished by the maintenance

Order Cycle



(Figure 1)

Base-Level Logistics System
Order Cycle



(Figure 2)

organization. The functions of searching for and providing the correct parts are accomplished by the supply organization. The output of this system is mission-capable aircraft. Identification of failure part and ordering procedures are related with the order preparation and transmittal activity. The functions of searching for and providing the correct parts are accomplished through the order receipt, order entry, order processing, warehouse picking and packing and order transportation activities. The function of delivering the parts is handled by the customer pick up and delivery organization. Overall system effectiveness can be measured by the A/C readiness rate. However, this measurement by itself is not enough to detect the deficiencies in the process. Other measures, highly correlated with the A/C readiness rate (such as lead time, repair time, data reliability, inventory level, skills and availibility of personnel, investment, and annual expenditure) must be measured to find the deficiencies in the subsystems.

In this study, three main criteria are used to measure the effectiveness of each of the three base-level supply and maintenance communication models. These are:

1. Flown sortie rate.
2. NMC aircraft.
3. NMC hours/hole.

II. Alternative Systems

The purpose of this chapter is to introduce the following three base-level logistics system's order and management information models. These models are:

1. The TUAF manual base-level order and management information model.
2. The TUAF RDS base-level order and mangement information model.
3. The USAF F-16C/D base-level COMO/COSO order and management information model.

The current structure of the TUAF Logistics System organization, and communication functions will also be summarized to explain the environment of the investigated models.

Background

After World War II, there was a close military relationship between the United States and Turkey. This relationship evolved from:

1. The geographical proximity of Turkey to the Soviet Union.
2. The vital oilfields in the Middle East.
3. Proximity of Turkey to the nations of Western Europe.

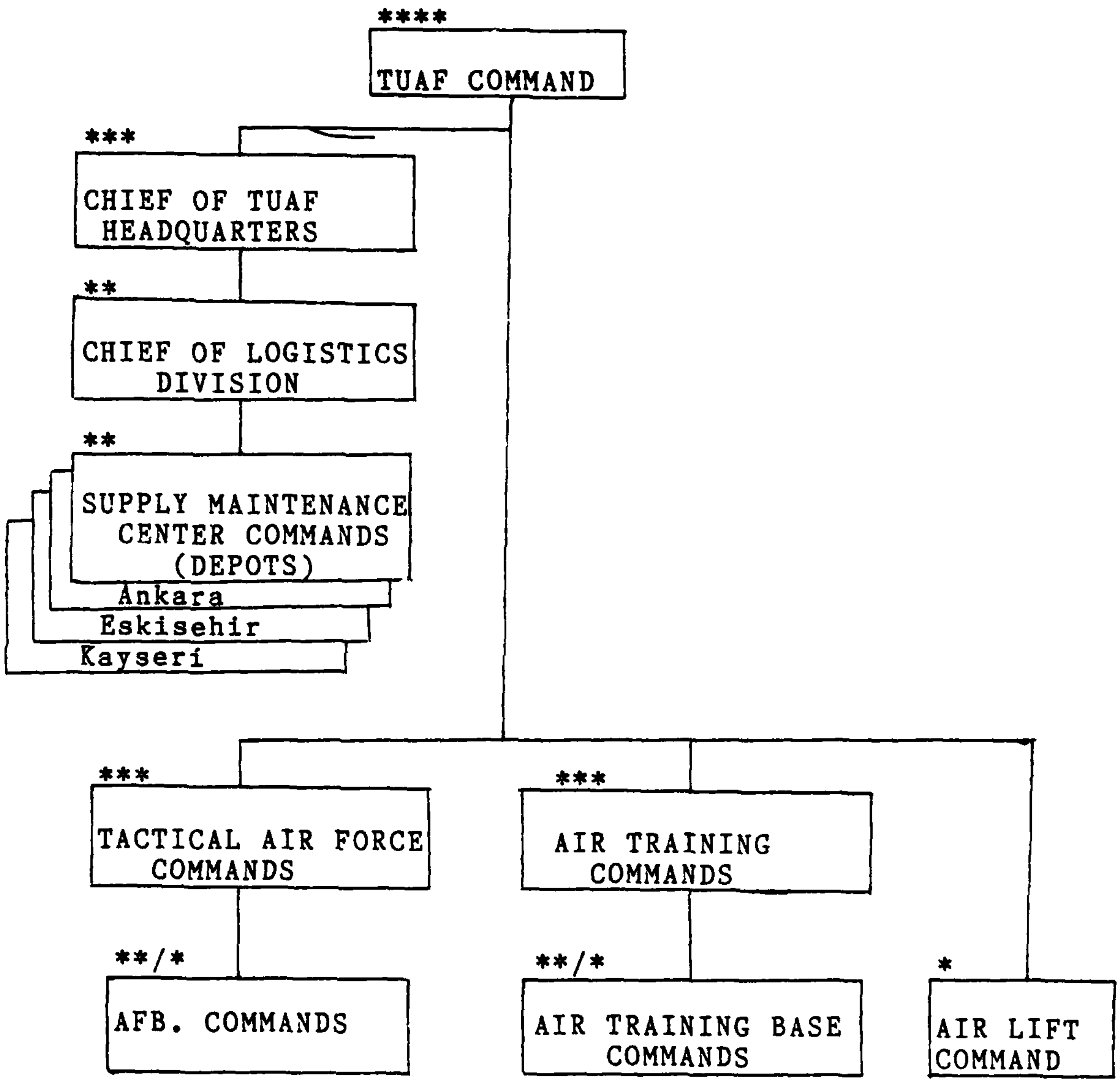
As a result of this relationship, the U.S. Defense Industry became the only weapon source for Turkey between 1947 and 1974 (18:1). However, because of the Turkish military activity in Cyprus in 1974, the U.S. Congress placed an embargo on Turkey between 1975 and 1978. During the three years of embargo, Turkey experienced many problems supporting its military. The U.S. embargo created many weaknesses in Turkish weapon systems (18:31-51). As a result of these weaknesses, two modernization programs were adopted by the TUAF after the U.S. lifted the embargo. One of these program is known as the REMO II which was adopted in 1981 to improve logistics capabilities(9). The other is the Peace Onyx (F-16) Program which was approved in 1983 to modernize aging Turkish aircraft (10).

As one of the long range objectives of the REMO-II program, the RDS program has been developed to improve communication between maintenance and supply, and to develop information capabilities at the base and depot levels. More detailed information about RDS is contained in Appendix B.

The Current TUAF Logistics System

The current structure of the TUAF Logistics System is shown in Figure 3 (15). The elements of this system are disscused below.

Current TUAF General Structure



(Figure 3)

The Turkish Air Force Command Headquarters

HQ TUAF is located in the capital city of Ankara and organizes staff functions in five major divisions. The divisions are Operations, Plans and Principles, Medical, Logistics and Personnel(5:19).

HQ TUAF Logistics Division is responsible for producing and maintaining logistics policies and procedures in support of operational forces. These policies must allow for adequate operational support within limited budget constraints. The Logistics Division supports policies and procedures dealing specifically with the areas of facility engineering, supply, maintenance, and procurement (5:19).

Although some data automation exists at the HQ level, the majority of the logistics processes are currently performed manually. The communications system is very limted among HQ TUAF, the three Maintenance and Supply Centers and the twelve air force bases. When availible, voice communication is often of poor quality and is a hindrence to logistics coordinating activities. Data communication in the TUAF is non-existent (5:20).

Maintenance and Supply Centers

The Maintenance and Supply Centers, hereafter referred to as Centers, are assigned primary repair, manufacturing and supply responsibilities for specific TUAF weapon systems. The three TUAF Centers, located in Ankara, Eskisehir and Kayseri, are given total responsibility for all assigned weapon systems for the 12 bases. The Ankara Center is responsible for assigned maintenance and supply of radar, communications, and electronics systems. The Kayseri Center is responsible for all propeller-driven and turbo-propeller-driven aircraft, engines, and related components and accessories. The Eskisehir Center is responsible for all jet aircraft, jet engines, and components for these systems. In addition to its maintenance function, each Center assumes primary supply responsibility for selected weapons systems and/or Federal Stock Classes (FSC). In general, the Center functional structure is similar to the AFLC structure for Air Logistics Centers (ALC) (5:19).

Although the present system seems adequate on the surface, many shortfalls exist which pose serious logistical problems. Item management and system control are almost non-existent between each Center and HQ TUAF because of a lack of communication. Some items are stocked at more than one Center with no procedure for monitoring these duplications. Multiple inventory locations require greater overall quantities and unnecessary additional inventory holding costs. Production and technical management are also lacking in the present system. Moreover, the manufacturing and repair equipment at these Centers is outdated (5:20).

Operating Bases

At the lower end of the TUAF Logistics chain are the twelwe operating bases located within Turkey's geographical boundries. The operating bases are assigned specific missions by HQ TUAF Operation Division in the areas of transport, training or tactical warfare. The weapon systems and commodities at the operating bases are supported by specific Centers. The kind of support given at a Center depends upon the type of weapon system and/or item assigned there. The operating base supply process includes base level issue, receipt and backorder procedures in support of operational needs (5:20).

The General Base Organizational Structure

The logistics units at the base are not under the supervision of only one logistics organization. They are organized in accordance with their activities. The posture of the logistics units in a base is as given in Figure 4 (15). Description of the TUAF base-level maintenance and supply organizations responsibilities and functions, based on AFM 66-1 and AFM 67-1 are detailed in Appendix A.

The TUAF Base-Level Maintenance Organization

The maintenance organization and operations are accomplished according to TUAF manual, Hava Kuvvetleri Yonergesi (HKY), 66-1 that was adopted from Air Force Manual

(AFM) 66-1 (20). As a summary, this manual prescribed a maintenance management concept that included:

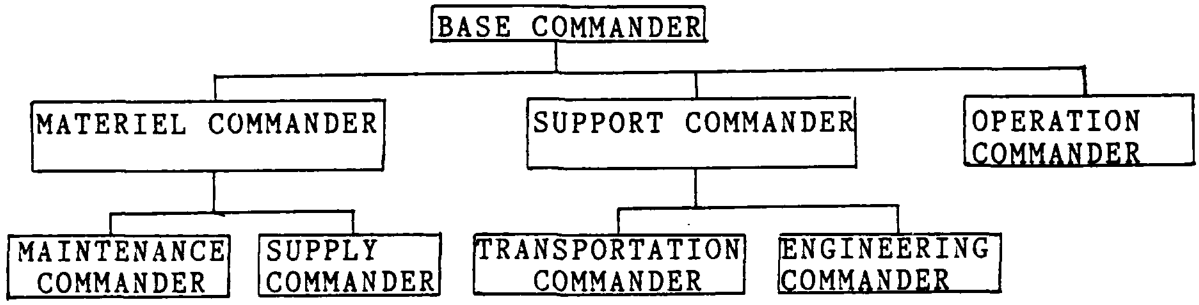
1. A top manager, with a staff, responsible to the commander for all actions on assigned equipment.
2. Decentralized maintenance functions, but with centralized control of all maintenance by a staff function known as maintenance control.

The original TUAF base-level maintenance organization structure is given in Figure 5 (15). Under the control of the maintenance commander, there are five maintenance commander staff units (maintenance superintendent, maintenance control, quality control, materiel control and simulator maintenance) and three different types of submaintenance (squadron) commands, the actual number of which depends on the number of flying squadrons.This structure resembles the USAF maintenance organization structure of AFM 66-1 shown in Figure 6.

Responsibilities and functions comparison of both organizations (Table I) and a detailed explanation of the centralized maintenance organization's functions are in Appendix A.

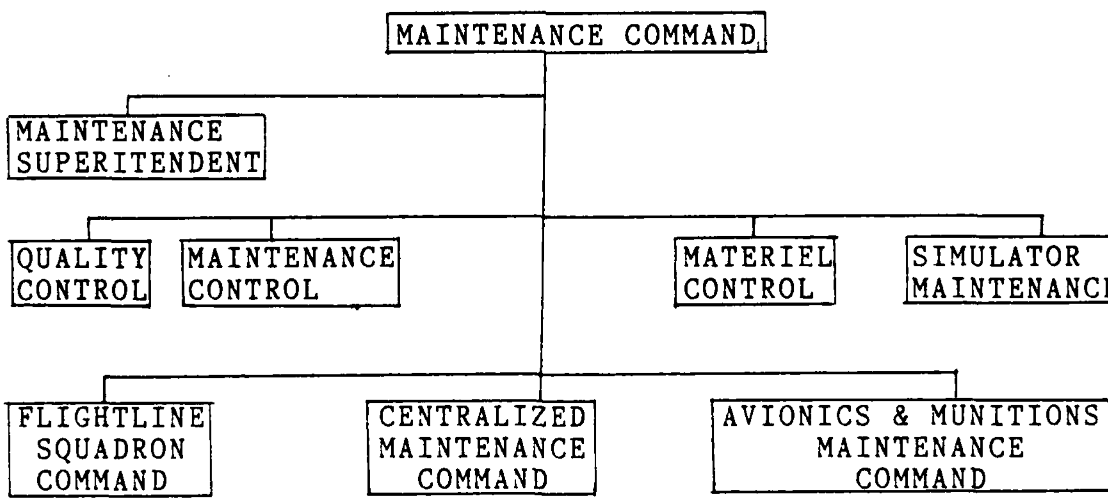
As shown in Table I, the TUAF maintenance commander has the same responsibilities as the USAF Deputy Commander for Maintenance. Maintenance superintendent and training management units' functions in the USAF maintenance organization are executed by the maintenance superintendent

TUAF Base Organizational Structure



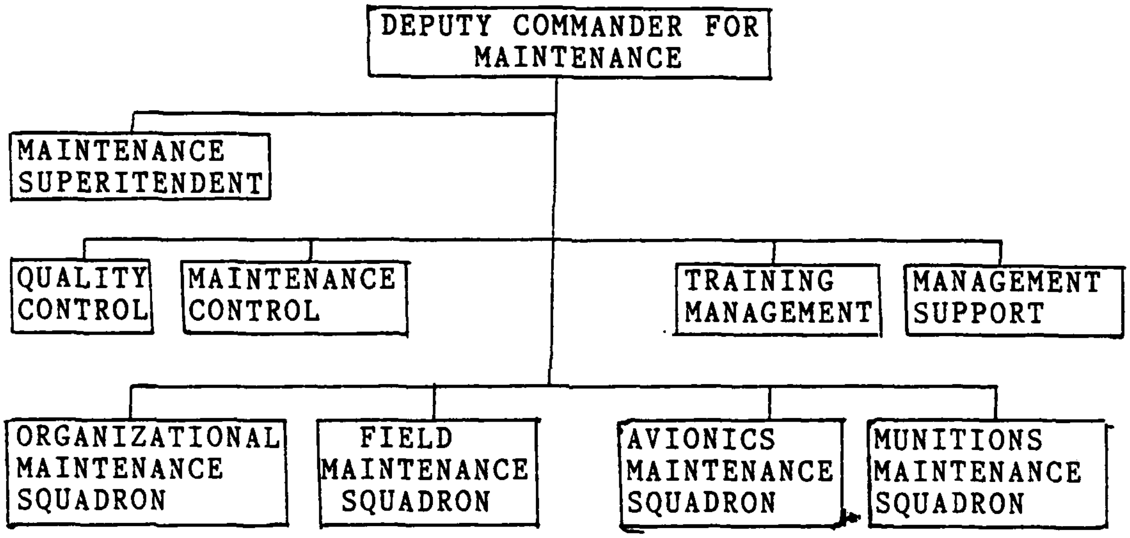
(Figure 4)

TUAF Base-Level Maintenance Organization Structure
(Centralized)



(Figure 5)

The USAF Base-Level Maintenance Organization Structure
(Centralized)



(Figure 6)

Table I

Comparison of The TUAF AND USAF Base-Level Centralized Maintenance Organizations

THE TUAF BASE-LEVEL MAINTENANCE ORGANIZATION	THE USAF BASE-LEVEL MAINTENANCE ORGANIZATION
MAINTENANCE COMMANDER	DEPUTY COMMANDER FOR MAINTENANCE
MAINTENANCE SUPERINTENDENT	MAINTENANCE SUPERINTENDENT
	TRAINING MANAGEMENT
	MANAGEMENT SUPPORT
MAINTENANCE CONTROL	MAINTENANCE CONTROL
MATERIEL CONTROL	
QUALITY CONTROL	QUALITY CONTROL
SIMULATOR MAINTENANCE	
AVIONICS & MUNITIONS MAINTENANCE COMMAND	AVIONICS MAINTENANCE SQUADRON
	MUNITIONS MAINTENANCE SQUADRON
FLIGHTLINE SQUADRON COMMAND	ORGANIZATIONAL MAINTENANCE SQUADRON
CENTRALIZED MAINTENANCE COMMAND	FIELD MAINTENANCE SQUADRON

in the TUAF maintenance organization. The Maintenance Superintendent unit in the TUAF carries out some part of the management support unit's functions. In the USAF maintenance organization, job control, planning and programing, and material control functions are executed by the maintenance control unit. In the TUAF maintenance organization, job control, and planning and programing functions are executed by the maintenance control unit, on the other hand material control functions are executed by a separate material control unit. The USAF and TUAF quality control units in the maintenance organization execute the same functions. The TUAF maintenance organization does not have the management support unit. However, this unit's functions are executed by the maintenance control, material control, and the maintenance superintendent. On the other hand, the USAF maintenance organization does not have simulator maintenance unit. This unit's functions are executed by the avionics maintenance squadron. Flightline squadron command in the TUAF maintenance organization functions like the organizational maintenance squadron in the USAF maintenance organization. Centralized maintenance command in the TUAF maintenance organization has the same responsibility as the field maintenance squadron in the USAF maintenance organization. Avionics and munitions maintenance's functions are combined in the TUAF structure (20).

The TUAF Base-Level Supply Organization Structure

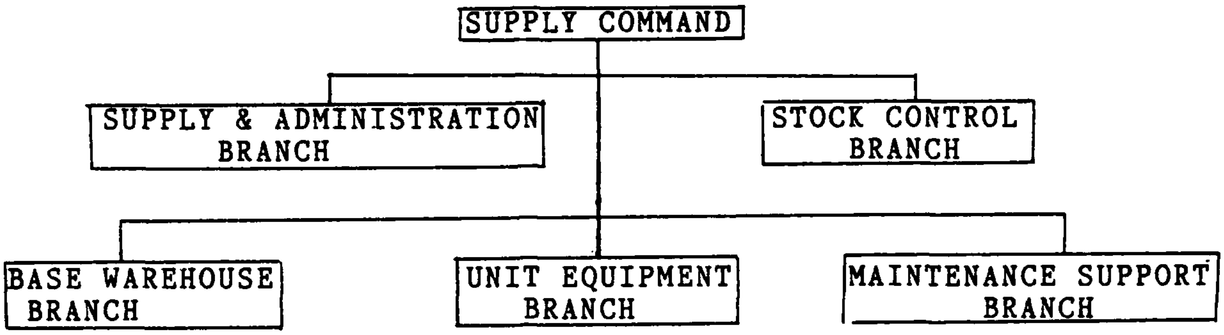
The supply organization and responsibilities are accomplished according to HKY 67-1 that was translated from AFM 67-1 (20). This manual prescribes the mission of base supply which is to provide effective and efficient supply, equipment, and munition support to the wing mission and to assigned tenant units.

The TUAF base-level supply command organization's structure under HKY 67-1 is shown in Figure 7 (15). Under control of the TUAF base-level supply commander, there are five major sections. These are Supply and Administration, Stock Control, Base Warehouses, Unit Eguipment, and Maintenance Support Sections.

The USAF base-level supply organization' structure under AFM 67-1 is shown in Figure 8. Under control of the USAF base-level Deputy Chief of Supply, there are four major sections. These are Management and System (DMSP), Operational Support (DMSC), Material Managemnt (DMSM), and Material and Distribution (DMSD) sections (Appendix A).

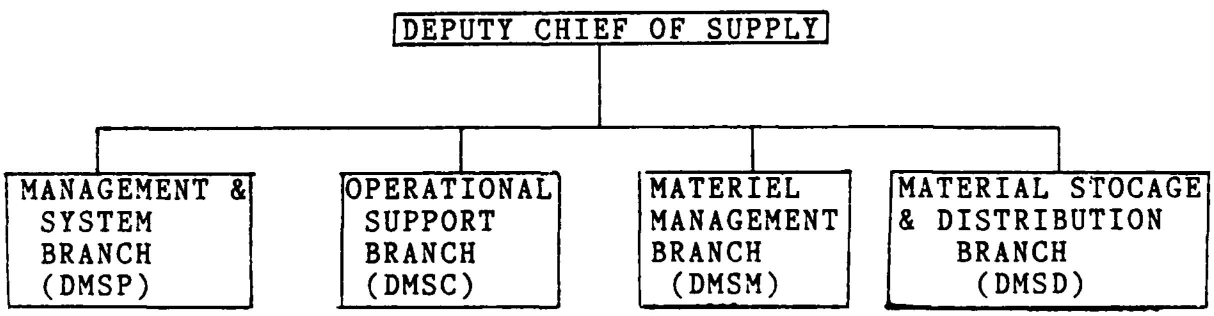
Responsibility and functional comparison of both organizations is contained in Table II and detailed explaination of the centralized supply organization's responsibilities are in Appendix A.

The TUAF Base-Level Supply Organization Structure
(Centralized)



(Figure 7)

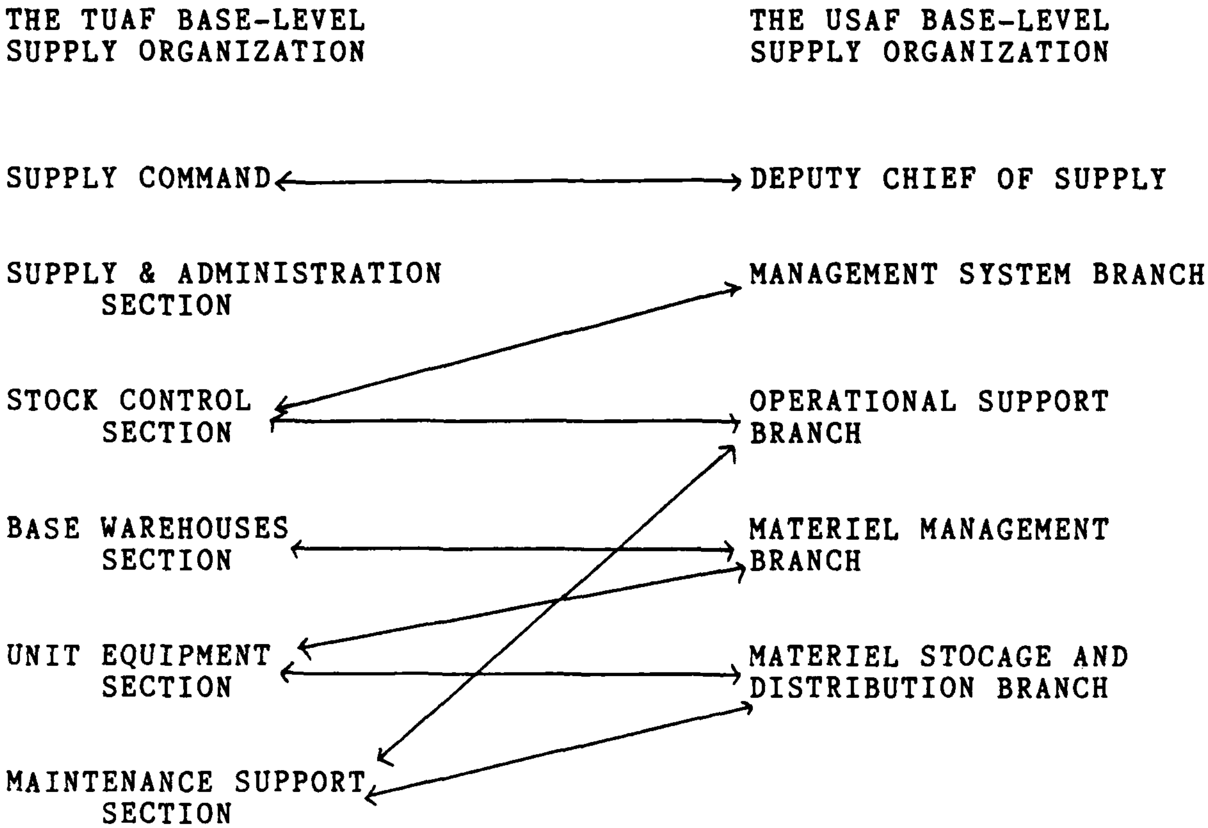
The USAF Base-Level Supply Organization Structure
(Centralized)



(Figure 8)

Table II

Comparison of The TUAF AND USAF Base-Level Centralized Supply Organizations



The TUAF Base-Level Maintenance and Supply Organizations Order and Management Information Model's Process (Centralized-Manual)

The TUAF current base-level maintenance and supply order and management information process is executed manually. This process can be divided into the following subprocesses which match base level maintenance and supply organizational structure:

1. Maintenance squadron's order and management information process.
2. Material control division's order and management information process.
3. Supply command's order and management information process.

On the maintenance side, an order begins with the declaration of not mission capable (NMC) aircraft by a pilot or during a scheduled inspection. After this declaration, the aircraft is checked to determine which maintenance squadron has responsibility for repair. If the job is related to another squadron, and it is necessary to send the aircraft to the responsible squadron, the NMC aircraft is towed to the responsible squdron. If it is not necessary to send the entire aircraft to the related squadron, only the failed LRU or SRU is sent.

After determining which shop will fix the failed part, the order process continues with identification of needs.

The technician who is assigned to repair the failed part first identifies how many parts he needs, and their manufacturers numbers, and stock numbers from catalogs or technical orders. (If a new part is not needed to fix the failed part, the technician repairs the failed part without waiting. Thus, the aircaft is available again without incuring an order from supply.) If the part is not repairable, after approval of the master shop chief, two copies of a requisition form (F-517) are prepared by the technician for a replacement. If the part is repairable, first the technician prepares a failure report. Then, after aproval of the master shop chief, two copies of F-517 are prepared by the technician. The technician then brings the F-517 and failure report and the failed item to the material control unit.

Beginning with the requisition verification, Maintenance Material Control recieves the requisition form (Form 517) from the maintenance technician and reviews the form for accuracy. If the paper work or data are not accurate, the forms are returned to the technician for correction or are corrected through a crosscheck with the technician who brings the forms. If the needed part is repairable, a control number is given to the requisition by recording the part on the Form 115, Reparable Item Control Record Book. Supply requsition forms (F-1150) are then prepared.

The Material Control Unit then forwards the F-1150 to the Recieving and Shipping or Stock Control Divisions of the Supply Command. If the needed part is repairable, the Receiving and Shipping Unit receives the F-1150 by signing and returning one of the copies the material control unit representative. This copy is held by the Material Control Unit in a suspense file until the order is sent.

The F-1150s are then checked by Stock Control. When accepted, three copies of the F-1150 are sent to the stock control chief for further verification. If the data or forwarding process are not accurate, they are sent back to the Material Control Division.

If the part is not repairable, Material Control then forwards the corrected forms to due Stock Control Chief of the Supply Command for further verification. The Stock Control Chief verifies such things as National Stock Number (NSN), accuracy of interchangeables and substitutes, and correct authorization before signing the requisition for the Supply Complex. The Document Control Unit completes the verification process by assigning a local document number to the requsition, thus updating the document number log. The Form 1150 is then forwarded for research.

Item research is initiated by the Research Subunit to collect all data necessary for demand processing. Research uses available microfiche and catolog data to obtain the necessary data. When all necessary data are not obtainable, the Form 1150 is returned to the requisitioner and to the

Document Control Unit for further research and verification. The requisitioner will confirm his requirement and such information as NSN, part number, and nomenclature before returning the Form 1150 through the Document Control Unit to research. When all necessary data are obtained, the Form 1150 is forwarded to the Stock Control Unit for demand processing.

In processing the demand, the Stock Control Unit initially determines if the item will be issued from base stock or requisitioned from an off-base source. If item availablity data shows an on-hand inventory balance at base level, the property is issued to satisfy the requisition and stock level records updated. If no on-hand balance exists, Stock Control records the document number as a backorder and creates a due-in record. Then the Form 1150 is sent to the requisition subunit for the establishment of a due-in. The Requisition Subunit processes the requisition to the appropriate Center and maintains requisition status on the items (1, 3, 9, 18:21-27, 20).

The TUAF Base-Level Maintenance and Supply Organizations Order and Management Information Model

Generally, one TUAF base has two flying squadrons. Because of TUAF logistics policy (centralized), every base has two Flight Line, one Centralized, and one Avionics and Munitions Maintenance Commands.

Each Flight Line Maintenance Command is responsible for one flying squadron, and is located near the flying squadron's aircraft parking area. On the other hand, Centralized,and Avionics and Munitions Maintenanace Commands are responsible for all the base's aircraft. These maintenance commands are centrally located to both Flight Line Maintenance Commands and near the taxiway. Maintenance Command Staff Divisions are located at the middle of both Flight Line Maintenance Commands, and near the other Maintenance Commands to provide for easy control, coordination, and commuication among the submaintenance commands. As seen in Appendix A, flight line squadrons do not have much responsibility for spares support. Most of the base-level repair responsibilities are given to the Centralized, and Avionics Maintenance Commands.

Supply Command also shows centralized management characteristics. Thus, the supply organization is located centrally to control and execute the part activity procedure between maintenance and supply. All the part activities between the Maintenance and Supply Commands are provided by the Maintenance Material Control Division in the Maintenance Command, and Stock Control Division in the Supply Command. For that reason, base-warehouse are located close to both divisions.

Representation of base Maintenance and Supply organization order and management information model is shown in Figure 9. Also part flows are illustrated in the same figure.

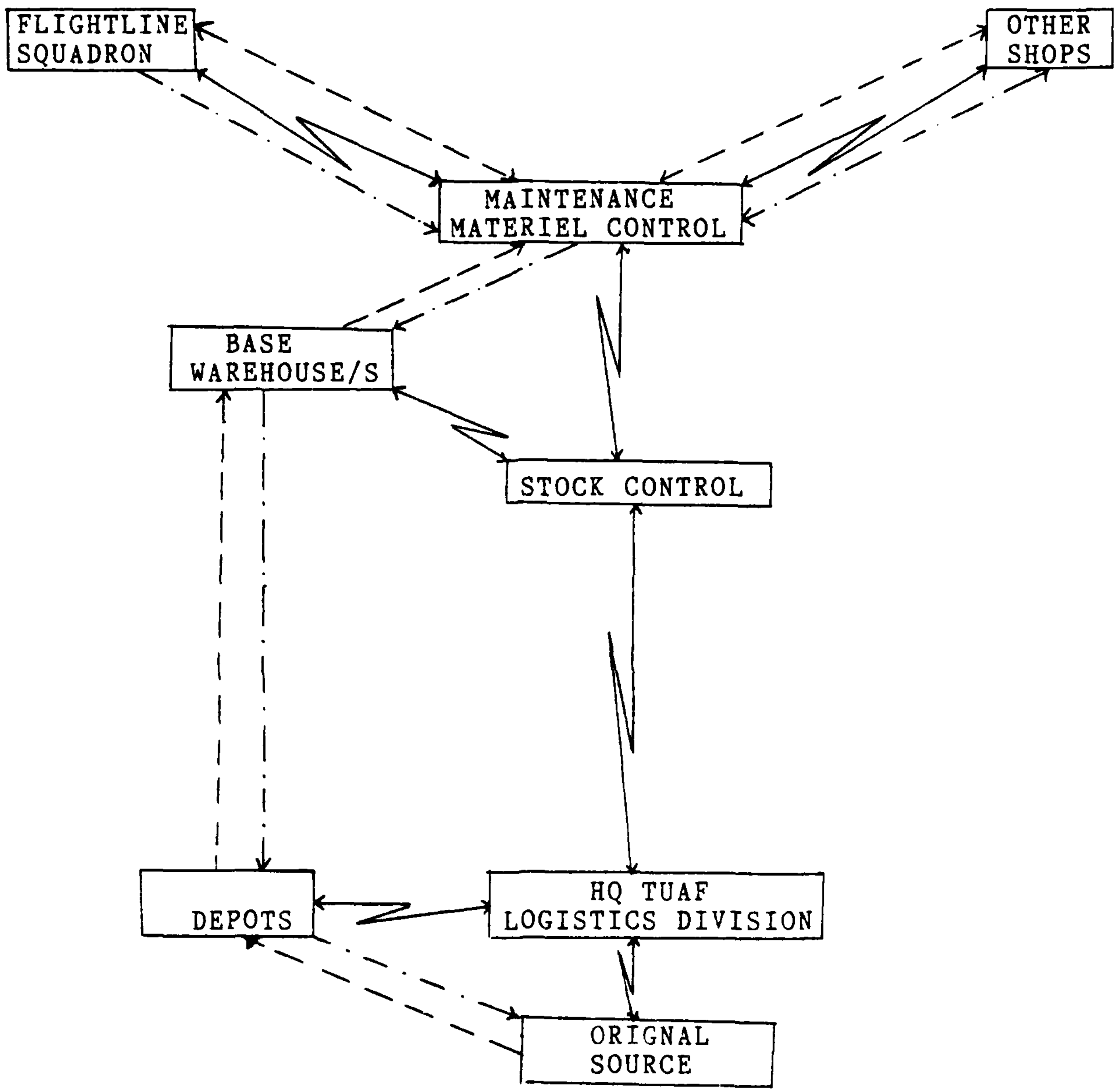
In accordance with this centralized logistics policy, all the logistics activities between the base supply and depot are controlled and monitored by the TUAF HQ Logistics Division. Only the phisical transfer of parts occurs between the base and depot levels. During this process, the base and depot communicate solely to monitor part status.

The Requirements and Distribution Program

The goal of the REMO II program is to achieve the long-range objective of improving and modernizing the Logistics Support System for the TUAF. To attain this objective, improvements must be realized in the areas of material management, maintenance, warehousing, transportation, financial management, procurement, engineering and technical support, plans and programs, and data automation.

The first major step under REMO II involves the improvement of supply support to TUAF organizations. This can be accomplished with improved supply management and expanded data automation. The second step requires the improvement of factory operations. Improved equipment and production management processing are required for enhancement in this area. The need for enhanced warehousing and transportation constitutes the third major step.

The TUAF Base-Level Maintenance and Supply Organizations
Order and Management Information Model
and Part Flows



(Figure 9)

By Direction Communication

- -Failed Part Activity

--Ordered Part Activity

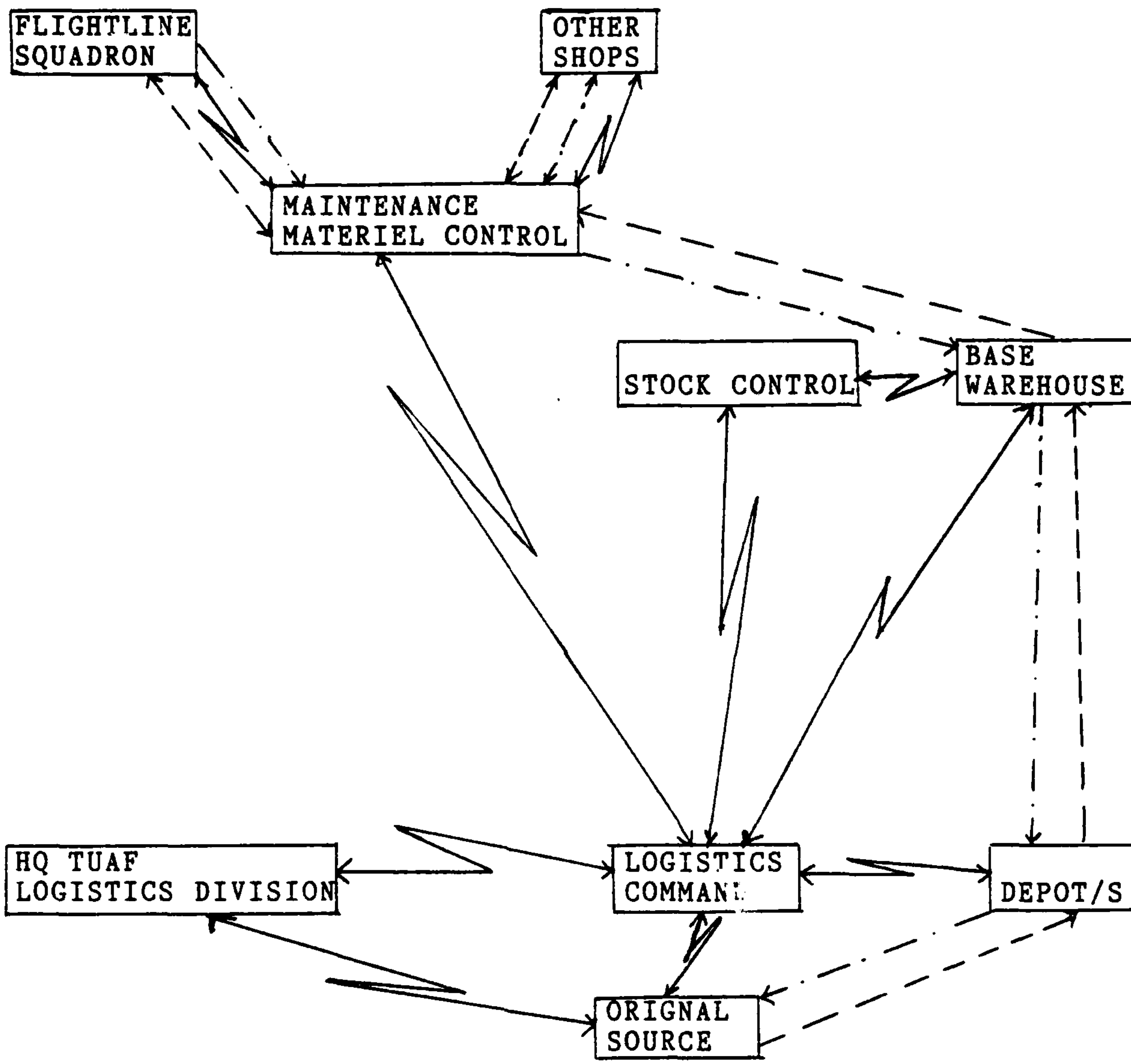
The fourth step is required in conjuction with the three steps previously mentioned. This step involves the integration of all logistics functions with the supply, factory, warehousing and transportation functions. This step requires improvment in the funds management, procurement, engineering and technical support, plans and programs and data automation functions as they interface with the initial three functions (5:49). More detailed knowledge about RDS programs are in Appendix B.

All control and monitoring functions of the base supply command, except local purchase, are to be executed by the item and system manager in the TUAF Logistics Command, instead of the TUAF HQ Logistics Division. The new RDS communication connections and part activities are illustrated in Figure 10. In the new model, the Maintenance Material Control Section has a direct connection with the item and system manager in the TUAF Logistics Command, instead of connection with the base-level supply command. This procedure is only used for a centralized purchase item order; the manual model still exists for local purchase items.

RDS Base-Level Maintenance and Supply Order and Management Information Model's Process (Centralized-Computerized)

There are no major differences between the manual and

The RDS Base-Level Maintenance and Supply Organizations
Information Model and Part Flows



(Figure 10)
By Direction Communication
Failed Part Activity
Ordered Part Activity

the RDS process. One of the minor differences is in identification of the item. Either the stock number, or manufacturer number is enough to identify the order in the RDS model. On the other har all item identification numbers are necessary to identify the part in the manual system.

Differences between the manual and RDS order and management information model begin in the maintenance material control section's function. After arrival of a requisition form (F-517) from the maintenance technician, the Maintenance Control Section first checks the data by entering the data into the computer. If information is not sufficient to complete the order, Maintenance Material Control request additional discriptions of the ordered part from the maintenance technician. After completing the input, the order message and suspense file records are prepared, than the order message is sent to the item manager in the Logistics Command. As soon as the order message arrives, the item manager checks the item availibility in the same base warehouses. If the ordered part is availible at the same base, the release message is sent to the base warehouse, along with information to the Maintenance Material Control Section.

If the ordered part is not availible in the same base warehouse, the item manager checks the depots and other bases respectively through the RDS, to find out which depot base has the ordered item in its inventory. After finding a source for the ordered item, an item transfer message is sent to the depot or base which has the ordered item, and transfer information messages are sent to the base supply and Maintenance Material Control which ordered the part. After tranfer has occured, a release message is sent to base warehouse, and release information message to Maintenance Material Control.

If the ordered item is not availible in the depots or other base inventory, a back order occurs. The item manager sends the back order information message to the base supply and Maintenance Material Control by creating the due-in record. After reciving the ordered part, and transfering the part to the base where the Maintenance Material Control Section ordered the part, the item manager applies the same release process as above.

After arrival of release message from the item manager to the base warehouse and Maintenance Material Control, the base warehouse packages the item, and Maintenance Material Control Section sends its representative to pick it up. After arrival of the ordered item at Maintenance Material Control, the suspense file record is closed, and the item is sent to the maintenance technician to fix the failed part. After fixing the failed part, the aircraft is again mission capable (1, 3, 9).

The USAF F-16 Base

General Base Structure

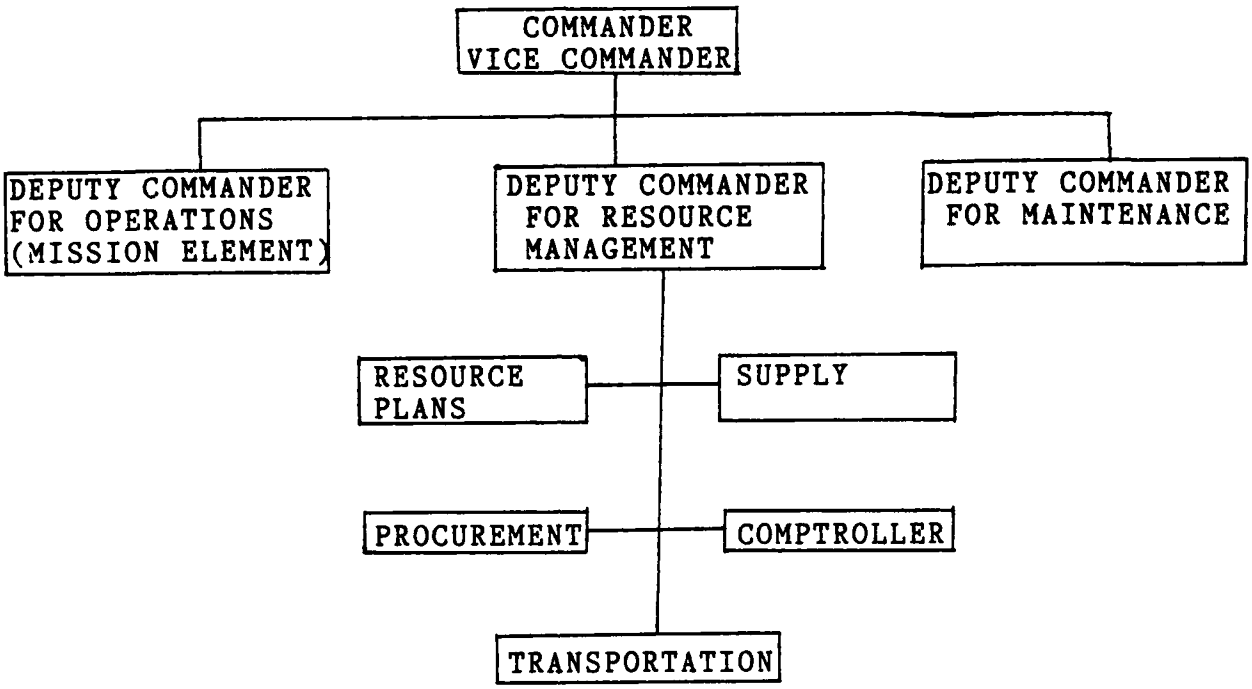
The USAF F-16 base structure is shown in Figure 11. Under the Wing Commander, there are three major deputy commanders. These are the Deputy Commanders for Oprerations, Resource Management, and Maintenance. As shown in Figure 11, the supply oganization functions under control of the Deputy Commander for Resource Management.

The Base-Level Combat Oriented Maintenance Organizational (COMO) Structure

The base level maintenance organization functions under control of the Deputy Commander for Maintenance. Today's F-16 maintenance organizations on tactical bases, are called Combat Oriented Maintenance Organizations (COMO). COMO is based on a decentralized maintenance policy according to MCR 66-5. Under COMO, there are 5 maintenance staff divisions (Maintenance Superintendent, Quality Control, Maintenance Control, Training Management, and Management Support sections) and 3 different maintenance squadrons (Aircraft Generation, Component Repair, and Equipment Maintenance Squadrons) (Figure 12).

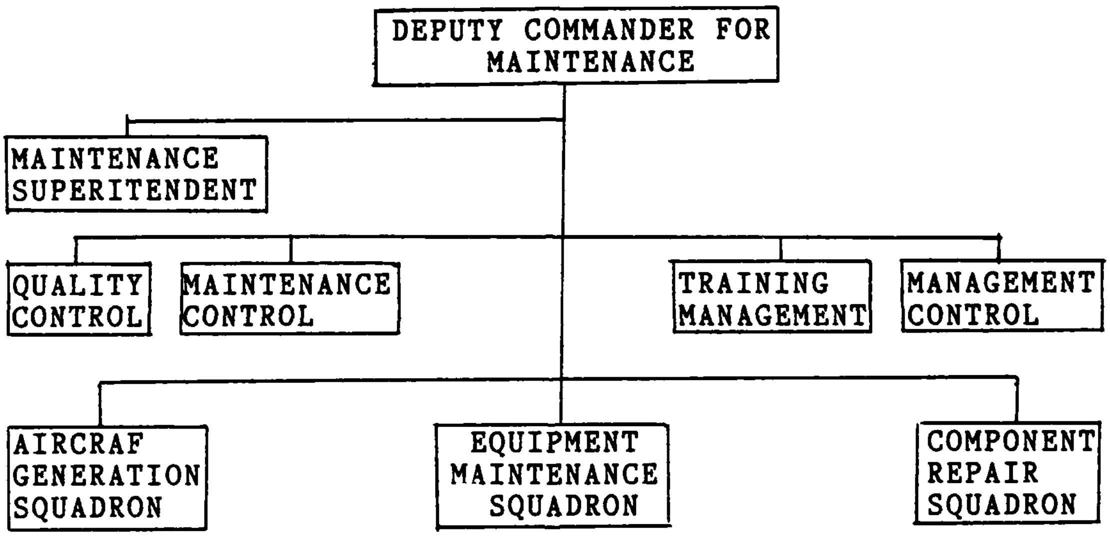
Maintenance Staff sections function as supervisors and coordinators among all maintenance squadrons under the decentralized maintenance policy. They drive the base

The USAF Base Organizational Structure



(Figure 11)

The USAF Base-Level COMO Structure
(Decentralized)



(Figure 12)

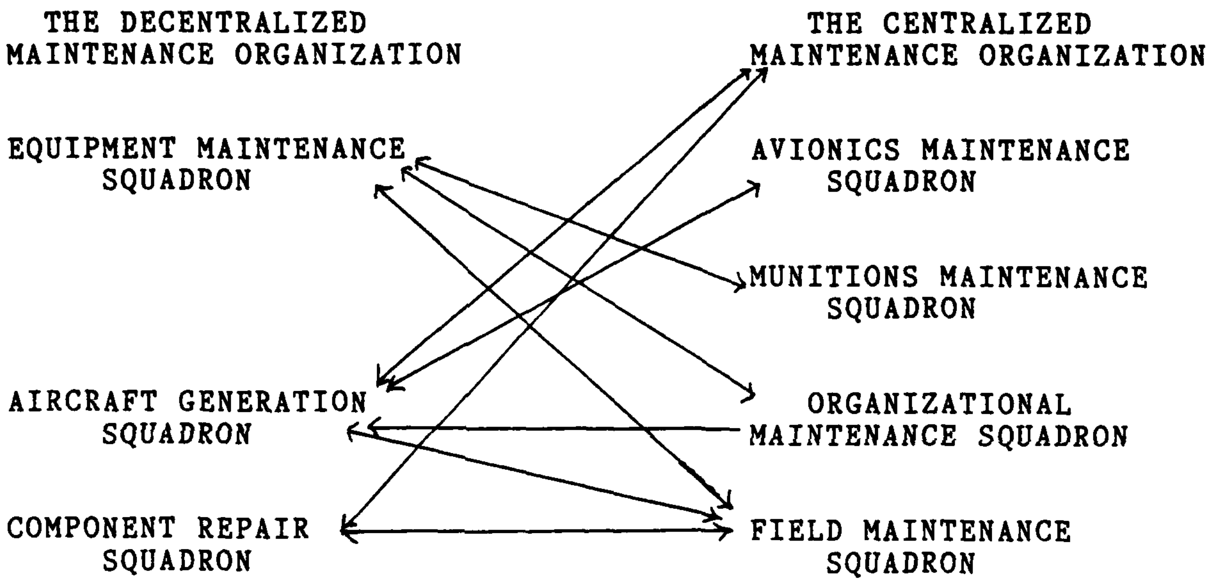
maintenance policy and control the functions of the maintenance squadrons. Each maintenance squadron operates individualy according to maintenance staff directions. The biggest difference between COMO and 66-1 is the maintenance squadron structures and functions. COMO has three different types of maintenance squadrons, where 66-1 centralized bases have four types of maintenance squadrons. The COMO flight line squadron (Aircraft Generation Squadron) has more repair responsibility and capability under the COMO policy than the centralized flight line squadron (Organizational Maintenance Squadron). Comparison of the centralized and decentralized maintenance squadrons is shown in Table III (more detailed information about COMO is in Appendix C.)

The Base-Level Combat Oriented Supply Organizational (COSO) Structure

The base-level Supply organization functions under control of Chief of Supply. Today's F-16 Supply organizations on tactical bases are called Combat Oriented Supply Organizations (COSO). COSO is based on a decentralized policy according to AFM 67-1 Vol 2, Part II to support the decentralize maintenance policy (COMO). It is the same as a standard base supply, except all COSO related functions are in the Operations Support Unit of the Operations Support Section. (See Appendix A) Under the decentralized policy, each flightline squadron has a

Table III

Comparison of The USAF Centralized and Decentralized Maintenance Structure



flightline supply warehouse to support its maintenance activity only. In the flightline warehouse, commonly used maintenance parts are stocked. Flightline supply warehouse functions under control of the Operations Support Unit and has responsibility to release the item which is in its stock. The Operations Support Unit functions as an supervisor and coordinator among the flightline supply warehouses. This unit drives the base supply policy and controls the activities of the flightline supply warehouses. Each flightline supply warehouse operates individually under the Operations Support Unit's directions.

The USAF COMO/COSO Order and Management Information Model's Process

There are no big differences between the COMO and centralized maintenance squadrons' order and management information model process. The only difference is that a maintenance technician goes directly to a flighline supply warehouse (forward supply point), located near the maintenance squadron, to pick up the part which he needs instead of going to the Maintenance Material Control with the requisition form. Each Aircraft Generation Squadron has one or more of these supply facilities to support their flying squadrons. After arrival at the warehouse, the supply demand process begins. First the order data is verified, then part availibility is determined. If the ordered part is availible at the supply point warehouse, a release process is applied and the ordered part is given to the technician immediately. If the desired part is reparable, then the failed part is returned to the warehouse for processing to maintenance.

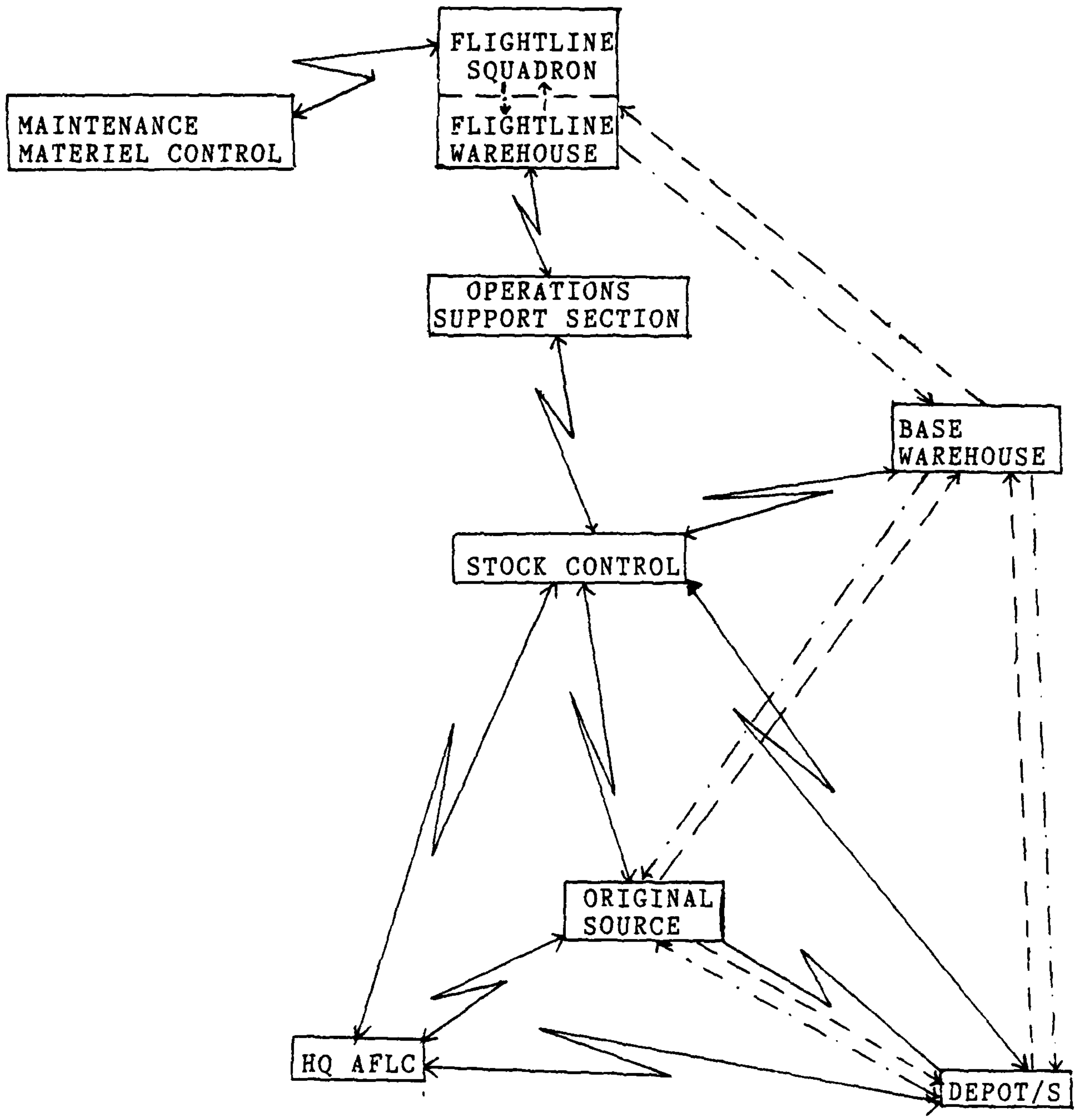
If the ordered part is not availible at the flighline, then, the base supply warehouse and other flighline warehouses are checked for availibility. If the part is available at an other warehouse on the same base, an issue message is given by the base-supply. If the part is not availible in the base warehouses, than a requisition message is sent to the depots which manages the needed item, or an item will be requisitioned from local purchase. When the requisitioned part arrives, supply transfers the part to the warehouse making the demand.

During the order process, the part number is verified one time by the computer and this verification is valid for each step in the process. Also, item visibility is provided by the computer to the Maintenance Material Control Section, and maintenance squadrons for each order phase if a backorder occurs (13, 17).

The USAF Base-Level COMO/COSO Order and Management Information Model (Decentralized-Computerized)

COMO/COSO model are represented in Figure 13 to clarify and show the differences among the three models of this

The USAF Base-Level COMO and COSO Order and Management Information Model and Part Flows



(Figure 13)

By Direction Communication
Failed Part Activity
Ordered Part Activity

chapter. Communication connections and part activities among the maintenance and supply organizations and their suborganizations are presented on the same figure. This figure also includes the communication connections and part flows between the base and depot levels.

Comparison of The Three Models

The TUAF Base-Level Maintenance and Supply Order and Management Information Models' process were designed according to centralized logistics management policies. RDS Order and Management Information Model' processes have been designed according to same policy. Under this policy, base maintenance and supply staff sections make detailed plans to control their activities, then schedule activities after the maintenance squadrons finish the given mission. The staff sections control the activity. In short the "do it exactly as I say" process is applied.

On the other hand, the USAF COMO/COSO Order and Management Information Model's process was designed according to a decentralized logistics management policy. According to this policy, maintenance and supply staff sections prepare the general instructions. Then maintenance sections make their indivudual plans, and send results to the staff sections for review. The"do it with your way according to my instructions" policy is applied.

The TUAF Base-Level Order and Management Information

Model is still working with the manual system. Communications tools are classic manual system tools where records have been kept by hand.

Under the RDS model, all order and information process will be executed with the computerized system. Also, communication connections for order and information processing between the base maintenance and supply organization are provided through the Logistics Command. All the monitors are directly connected to a centralized host computer, which will be located in the Logistics Command.

Under the USAF COMO/COSO model, all order and information process are executed with the computerized system.

As mentioned above, there is no differences between the TUAF manual model's Supply and Maintenance organizations and the RDS Supply and Maintenance Organizations except for computerized communications instead of manual communications. However the communications system connection change causes some functional changes in the supply organization which are explained below.

The USAF COMO/COSO staff sections do not differ much from 66-1 except the staff functions are executed under different names. The biggest difference occurs in the maintenance squadrons' and supply warehouses' personnel types and responsibilities.

There are many differences among the three model's supply and maintenance organization subdivisions. In the TUAF manual-centralized and the RDS centralized models, the Maintenance Control Section is responsible to provide what part the maintenance squadrons needs. On the other hand, the same section in the USAF has supervisory and coordination control responsibility, with each maintenance squadron responsible to provide their parts requirements directly to base supply warehouses. Flight line squadrons in the USAF COMO/COSO model have more repair responsibility and functional capability than the flight line squadrons in the TUAF manual and RDS models.

The Supply Stock Control Division in the TUAF manual model plays the most important role in supply by managing all other sections. However this section in the RDS model plays only a supervisory and control role. All of the real responsibility is given to the item and system managers centrally located in the Logistics Command. Forecasting, item purchases, releases, and transfers, are executed by the item and system managers. In the USAF COMO/COSO model, Stock Control is one of the most important sections. Because of the decentralized policy, other responsibilities have been given to this section as well, like purchase decisions, forecasting etc. Under COSO, warehouses located near maintenance squadrons have responsibility to release items, and accept the failed reparable items in return. They function like a small model of the base supply organization.

In the RDS, base warehouses will be an important division in the supply organization, because they will work directly under item and sytem managers. Base supply organizations may therefore become weak.

III. Methodology and Analysis

Introduction

This research was conducted in six phases with each phase corresponding to one of the six research objectives in the first chapter.

In the first phase, the TUAF Base-Level Maintenance and Supply Information Model was identified. The organizational structures and functions were outlined with emphasis on processes and communications connections among the related organizations, and on oranizational functions on the base. As part of this investigation, the historical background of the TUAF Logistics System Improvement Program and the Current TUAF Logistics System were summarized briefly.

In the second phase, the RDS project outline and its effect on the current TUAF Base-Level Maintenance and Supply Information Model was examined. Essential data were obtained from the REMO II Turkish Representative in Sacremento, California and TUAF HQ documentation in Ankara, Turkey.

In the third phase, the investigation examined how the USAF F-16 base level maintenance and supply organizations (COMO/COSO) operated. Specifically, this examination determined how each organization communicates within itself and with each other.

In the fourth phase, these three models, their management policies and communication channels, organizational structures, functions and locations were compared.

In the fifth phase, the three models were simulated with the TSAR model. The TSAR model is a computer program designed to simulate a system of interdependent theater airbases, supported by shipments from the CONUS and by intratheater transportation, communication and resource management systems. To compare the outputs off the three models, a paired difference test was used.

In the sixth phase, advantages and disadvantages of the models are summarized and recommendations made. Also, the author's observations about the TSAR model are presented.

Selection Criteria

In comparing the three models' capabilities, the following criteria were used:

1. Total sorties flown.
2. Daily average sorties.
3. Average sorties launched by hour.
4. Number of NMC aircraft.
5. NMC Hours.
6. Total number of holes.

Assumptions and Limitations

This study concentrated only on base-level maintenance and supply information model capabilities under centralized-manual, centralized-computerized and decentralized-computerized mangament policies. Assumptions and limitations are listed below:

1. There is no difference between the USAF and TUAF centralized maintenance and supply organization structrally, and functionaly.
2. Personnel skills, and facilities that effect the models are the same.
3. The data base which was used for the TSAR model is representative of a TUAF base's data.
4. A policy of no cannibilization exists.
5. No budget constraint exists.
6. No personnel constraint exists.
7. Aerospace ground equipment delays are assumed to be zero.
8. The only difference between the centralized and decentralized management policy is the delay time which is caused by the maintenance material control process and supply stock control process.

The first model represents the TUAF Base-Level Maintenance and Supply Order and Management Information Model. It was assumed that to obtain a part from base supply takes 180 minutes; to get the part from depot takes 20 days. Administrative delay takes 2 hours because of manual paper work. In addition, task times which inluded a part number on the Card Types #5, were increased by 180 minutes. This time of increase represents the manual processing time between the base-level maintenance and supply organizations. Additional personnel were added to eliminate extraordinary delays caused by the additional 3 hours in the part task network. The data base differentiation among the models is shown in Table IV.

The second model represents the RDS Base-Level Maintenance and Supply Information Model. Instead of centralized-manual system, a centralizad-computerized system is used without changing the organizational structures. Communication channels are changed because base supply's responsibilities move to the item and system managers assigned in the Logistics Command. Because of the computerized system, it was assumed that the acquisition of an item from base supply takes 90 minutes and to obtain the item from depots takes 10 days. Administrative delay was assumed as one hour.

The third model represents the USAF COMO/COSO Order and Management Information Model. In this model, delays due to processing by maintenance materiel control and supply stock control or item and system managers are reduced. In concept, the maintenance squadron deals directly with the base warehouses. It was assumed that to obtain the item from base supply takes zero time. On the other hand, to procure the item from the depot takes 10 days. Administrative delay

Table IV

The TSAR F-16 Data Base Differences

	TUAF MANUAL CENTRALIZED	RDS COMPUTERIZED CENTRALIZED	USAF COMPUTERIZED CENTRALIZED	CARD TYPE #
TASK TIME (HOURS)	60	30	0	5
ORDER/SHIP TIME (DAYS)	20	10	10	23/70
RESUPPLY OF PART RESOURCES (DAYS)	20	10	10	33
ADMINISTRATION DELAY (HOURS)	2	1	1	47/1

takes one hour.

Experimental Design

Input data was obtained from the F-16 TSAR Data Base Documentation prepared by Orlando Technology, Inc. for the Air Force Center for Studies and Analyses. The three models were simulated by changing the necessary control variables (in Card Type #1, 3/1,and 3/3), time variables on the Card Type #5, #23/70, #33, and #47, and source variables on the Card Type #23/0 and #21/0. Stock was automatically generated by using the TSAR automatic part generation feature. Card Type #33 was used to simulate the communication and transportation activities between the base and depot. The times used for the TUAF manual and RDS computerized models were arrived at subjectively. Simulations were run for 21 days, 21 trials. The number of trials and days were decided subjectively considering limitations on the computer.

Analysis of Three Models

Among the three models, The most successfull response was given by the USAF COMO/COSO decentralized model by providing 1759 sorties against 2268 required sorties. The sortie success rate of the model was 78 percent. The least sucessfull model was the TUAF manual centralized model. It provided 1493 sorties with a 66 percent rate. The RDS computerized-centralized model provided 1704 sorties with a

75 percent success rate. (Table V and VI)

Results show 2 NMC aircraft due to 2 holes with 458 delay hours under the TUAF manual model (Table V). The first NMC aircraft occured during the sixth day and the second occured an the seventeenth day (Table VI). On the other hand 4 NMC aircraft causing 533 delay hours were recorded under the RDS model and 6 NMC aircraft with 790 delay hours under the USAF COMO/COSO model. Although the highest number of NMC aircraft and hours occured under the USAF COMO/COSO model, the model provided the highest sortie rate and thus demanded more of the supply system. (Table V and VI)

When sorties by day were analyzed, the USAF COMO/COSO model produced an average of 84 sorties a day. The highest sortie production was 90 sorties in the third day and the lowest was 72 sorties in the last day. The daily sortie trend was decreasing (Table VI). The RDS computerized model provided 81 sorties a day. The highest was 85 sorties in the fifth day and the lowest sortie 73 in the last day. Its daily sortie trend was decreasing also (Table VI). The TUAF manual model provided 71 sorties a day. Its highest occured on the first day with 74 sorties. The lowest production was 68 sorties on the last day. Its daily sortie trend was also decreasing (Table VI). The reason for the decreasing sortie trend in all three models is likely the effect of the NMC aircraft and NMC hours.

Under the null hypothesis that there is no difference between the average daily sorties of the models, a paired difference test was applied between the USAF and TUAF, the USAF and RDS, and the RDS and TUAF results; 99 percent was selected as a Confidence Interval (CI). The computation indicates that the null hypothesis should not be accepted and we conclude that the evidence indicates a discernable difference in average daily sorties for each of the three models does exist.

When average sorties launched by hour was investigated, some fluctuations in sortie achievement among the launched windows were observed(Table VII, VIII, and IX). The smallest fluctuation occurs in the USAF model; the biggest occurs in the TUAF model. This is consistant with the total sortie findings above.

Table V

General Comparison of The Three Model's Results

	TUAF MANUAL CENTRALIZED	RDS COMPUTERIZED CENTRALIZED	USAF COMPUTERIZED CENTRALIZED
FLOWN SORTIES (HOURS)	1493	1704	1759
NUMBER OF NMC AIRCRAFT	2	4	6
NMC HOURS	458	533	790
HOLES	2	4	6
NMC HOURS/HOLE	229	133.2	131.6

Table VI

Comparison of The Sorties Flown, NMC A/C, Holes, and NMC Hours For The Three Models
(108 Sorties Required Each Day)

	TUAF MANUAL MODEL				RDS MODEL				USAF MODEL			
DAYS	FLOWN SORTIE	NMC A/C	TOT HOLE	NMC HOUR	FLOWN SORTIE	NMC A/C	TOT HOLE	NMC HOUR	FLOWN SORTIE	NMC A/C	TOT HOLE	NMC HOUR
1	74	0	0	0	84	0	0	0	89	0	0	0
2	73	0	0	1	82	0	0	0	87	0	0	0
3	72	0	0	2	82	0	0	1	88	0	0	2
4	72	0	0	5	83	0	0	2	90	0	0	6
5	71	0	0	10	85	0	0	3	88	0	0	14
6	72	1	1	19	84	0	0	8	88	0	0	21
7	72	1	1	33	85	0	0	11	88	0	0	29
8	73	1	1	47	84	0	0	17	89	1	1	37
9	72	1	1	64	83	0	0	24	88	1	1	49
10	71	1	1	85	83	1	1	32	86	1	1	65
11	72	1	1	106	83	1	1	46	87	1	1	85
12	72	1	1	129	83	1	1	67	86	1	1	112
13	70	1	1	153	81	1	1	95	84	2	2	143
14	70	1	1	179	81	2	2	127	83	2	2	184
15	72	1	1	207	79	2	2	167	83	3	3	235
16	70	1	1	235	80	2	2	210	80	3	3	299
17	70	2	2	270	78	2	2	259	79	4	4	378
18	70	2	2	309	76	3	3	312	76	4	4	467
19	69	2	2	350	79	3	3	376	76	4	4	563
20	68	2	2	400	75	3	3	451	74	5	5	670
21	68	2	2	458	73	4	4	533	72	6	6	790
SUM	1493				1704				1759			
AVG	71				81				84			
SIGMA	1.6				3.3				5.5			
SUC	%66				%75				%78			

SUM=TOTAL
AVG=AVERAGE
SUC=SUCCESS

Table VII

Launched Sorties by Hour of a Day

(USAF COMO/COSO Model)

	HOURS							
DAYS	6	9	11	13	15	17	19	21
1	24	08	14	07	13	08	08	08
2	22	08	12	07	12	08	09	08
3	23	07	13	07	13	07	11	08
4	23	08	12	07	13	08	11	08
5	23	08	12	07	13	06	11	08
6	22	08	12	07	12	07	12	08
7	22	08	12	08	12	08	11	08
8	22	08	13	07	12	07	11	08
9	22	08	12	08	12	08	12	08
10	21	08	12	07	11	07	12	08
11	22	08	12	07	12	07	11	08
12	21	08	11	07	11	07	11	08
13	21	08	10	08	11	07	11	08
14	21	08	10	07	11	07	11	08
15	21	08	11	07	11	07	10	08
16	20	08	11	07	10	07	10	08
17	20	08	09	07	10	07	10	08
18	19	08	09	07	09	07	09	08
19	18	08	09	06	10	07	09	08
20	18	08	09	07	09	07	08	08
21	17	07	09	07	08	07	08	08
SUM	442	166	234	149	235	151	216	168
AVG	21	8	11	7	12	7	11	8
SIG	1.8	.3	1.5	.4	1.4	.5	1.3	0
REQ	24	8	16	8	16	8	20	8
SUC	%87	%98	%69	%88	%69	%89	%51	%100

SUM=TOTAL
AVG=AVERAGE
SIG=SIGMA
REQ=REQUIRED
SUC=SUCCESS

Table VIII

Launched Sorties by Hour of a Day

(RDS Model)

DAYS	6	9	11	13	15	17	19	21
1	24	03	16	05	12	07	08	08
2	23	03	15	05	12	07	09	08
3	22	03	15	06	12	07	09	08
4	23	03	15	05	13	07	11	08
5	23	03	15	05	13	07	11	08
6	22	03	15	06	12	07	11	08
7	23	03	15	06	12	07	11	08
8	22	03	15	06	13	06	11	08
9	22	03	15	04	12	07	11	08
10	22	04	15	05	12	07	11	08
11	22	03	15	05	12	07	11	08
12	22	03	15	05	12	07	11	08
13	22	04	15	05	12	06	11	08
14	21	05	14	06	12	06	10	08
15	21	04	14	05	11	07	10	08
16	21	03	15	05	12	06	11	08
17	21	03	14	04	12	06	10	08
18	20	02	15	04	12	06	09	08
19	20	03	15	04	12	06	11	08
20	20	03	15	03	12	05	10	08
21	19	02	14	04	11	06	09	08
SUM	455	66	311	103	253	168	173	168
AVG	22	3	15	5	12	6	10	8
SIG	1.2	.7	.6	.8	.5	.6	.9	0
REQ	24	8	16	8	16	8	20	8
SUC	%90	%39	%92	%61	%75	%81	%51	%100

(Column header "HOURS" spans the hour columns 6–21.)

SUM=TOTAL
AVG=AVERAGE
SIG=SIGMA
REQ=REQUIRED
SUC=SUCCESS

TABLE IX

Launched Sorties by Hour of a Day

(TUAF MANUAL Model)

	HOURS							
DAYS	6	9	11	13	15	17	19	21
1	24	01	16	05	04	08	08	08
2	22	01	15	05	05	08	08	08
3	22	01	15	05	05	08	08	08
4	22	02	14	05	06	08	08	08
5	21	02	14	04	05	08	08	08
6	22	02	15	05	05	08	08	08
7	22	01	15	04	05	08	09	08
8	23	01	15	05	05	08	08	08
9	22	02	15	05	05	08	09	08
10	21	02	15	04	05	08	08	08
11	21	01	15	05	04	08	09	08
12	22	02	14	05	05	08	08	08
13	21	01	15	04	05	08	08	08
14	21	02	14	04	05	08	09	08
15	21	02	14	06	04	08	09	08
16	21	01	14	05	04	08	08	08
17	21	01	15	05	04	08	08	08
18	21	01	15	04	05	08	08	08
19	21	02	15	04	05	08	08	08
20	20	02	14	03	05	08	08	08
21	20	02	14	04	04	08	08	08
SUM	451	32	308	96	100	168	173	168
AVG	21	2	15	4	5	8	8	8
SIG	.9	.5	.6	.7	.5	0	.4	0
REQ	24	8	16	8	16	8	20	8
SUC	%89	%19	%91	%57	%29	%100	%41	%100

SUM=TOTAL
AVG=AVERAGE
SIG=SIGMA
REQ=REQUIRED
SUC=SUCCESS

IV. Conclusion and Recommendations

Conclusion

The results of this study indicate that the USAF base-level COMO/COSO order and management information model policy gives the highest sortie rate as well as the highest non mission capable aircraft and non mission capable hours for given order and ship time. The lowest non mission capable hours per hole was provided by this model. The model provided the highest and most steady response to required sortie by hour in a day.

The RDS base-level computerized order and management information model gives the second highest sortie rate and the second highest NMC aircraft, holes, and NMC hours. However, it does not demonstrate as good an ability to meet the sortie schedule.

The result also indicated that the TUAF base-level manual order and management information model is the least desirable model because it produces the lowest number of sorties. It is also unable to meet sortie schedule predictably and is deficient on other measures.

While indications are that the USAF COMO/COSO models is the most dynamic and responsive model, the experimentation to date is sufficient to say clearly that the USAF COMO/COSO model is more desiarable than the RDS model. Its achieved sorties are only three percent higher than the RDS model with other measures of merit giving the same type of indication. However, the computerized communication system seems to demostrate superior performance versus the manual communication system by yielding significant differences accross the board. Clearly time delays due to communication and order and ship time are two of the important control variables in determinig the best logistics policy.

Recommendations

While the TSAR program is a good tool for evaluation of alternative logistics policies, the results of this research are certainly not definitive. Nonexistence of personnel, equipment and budget constraints, and limitation of the analysis to differences in communication and order processing time limit its applicability. The results do indicate the potential payoffs of further study, utilizing actual TUAF data.

APPENDIX A

BASE-LEVEL CENTRALIZED MAINTENANCE AND SUPPLY ORGANIZATIONS

Base-level Centralized Maintenance Organization (12:14/10-13)

USAF Manual 66-1 prescribes a maintenance management concept that includes:

1. A top manager, with a staff, responsible to the commander for all actions on assigned equipment.
2. Decentralized maintenance functions, but with centralized control of all maintenance by a staff function known as maintenance control.
3. A mechanized maintenance data collection system that includes workhour accounting, maintenance actions, and status reporting.

Organizations and Responsibilities

The Deputy Commander For Maintenance (DCM)

The DCM is responsible for the management and leadership of the entire maintenance complex. The responsibilities are awesome because the position involves considerably more than being merely concerned with the timeliness and quality of maintenance production. DCM areas of responsibility also include sustainable rates of production; assignment of all maintenance personnel; control and management of financial programs and facilities; and the existence of a viable and comprehensive training program. Additionally, the DCM has three or four subordinate maintenance squadron commanders who share in the responsibility for direct involvement with the morale and welfare of a huge workforce.

Chief Enlisted Manager/Maintenance Superintendent

The DCM has a chief enlisited manager or maintenance superintendent assigned to his or her office. Usually, the maintenance superintendent is the senior NCO in the complex whose capabilities, when properly used, can be invaluable. This NCO serves as a technical and morale and welfare advisor to the DCM and may act as liason between the staff and production elements.

Maintenance Control Division

Maintenance control is the staff function responsible for scheduling and directing the maintenance effort. As a rule, the maintenance control officer is the senior maintenance officer in the complex, and the DCM's agent for the quantity of production. As such, he or she determines the maintenance capability, schedules the aircraft, and allocates equipment priorities, facilities and material sources. The maintenance control officer also approves requests for cannibalization and local manufacture and is the prime maintenance coordinator with base supply. He or she is also responsible for status reporting and maintaining records. Another major concern is the availability and status of maintenance vehicles and communications. To execute these responsibilities, there are three functional elements: job control; materiel control; and plans and scheduling (P&S) and documentation.

Job Control: Job control is responsible for the overall command and control of the maintenance effort. It is the nerve center of the entire maintenance operation. It directs the implementation of the flying schedule, the scheduled maintenance plan, and control of all, or pertinent, unscheduled maintenance. Job control assigns work priorities and attendent equipment, supply, and facility priorities. In every production type organization, job control is the central communication point for all required services, support, and problem resolution. The controllers are also responsible for the continued updating of aircraft status within the mechanized system.

Materiel Control: This agency serves as the interface between maintenance and supply, manages supply transactions for maintenance, and monitors the repair or production of assets. The agency operates generally on a passive exception basis. It becomes active when a maintenance technician orders a part from base supply and there is none available. When this happens, a verification-of-need process begins. The first step is research for a substitute item. Once verified, the item is reordered from base supply and detailed records are kept until the required part is received and installed on the appropriate equipment. This process must be closely coordinated with both job control and the requester to insure accurate status and planning factors. Material control is also concerned with the documentation of special supply levels in maintenance, cannibalization actions, and the preprogramming of future part requirements. Material control also insures positive asset control by monitoring the flow and status of those parts undergoing local repair through the due-in-from-maintenance (DIFM) program.

Plans and scheduling (P&S) and documentation: This section discusses two distinct functions: Plans and Scheduling (P&S) and documentation. Plans and Scheduling is responsible for developing and publishing monthly and weekly maintenance plans that include both operational requirements and flying schedules and scheduled maintenance requirements. Documentation is concerned with keeping accurate historical documents and all maintenance data that are essential in the planning and scheduling of maintenance.

Because of the integral role played by the maintenance control staff, a multitude of performance data are available within this function. The maintenance control officer and DCM have ready access to the current status of all aircraft, ICBMs, and equipment including actual versus scheduled performance; status of parts in the repair cycle; aircraft and ICBM systems that have the most serious problems; availability and performance of maintenance technicians; and a projected capability to accomplish operational requirements.

Quality Control/Quality Assurance Division

Quality control or quality assurance serves the DCM in an inspection, technical advisory, and technical data capacity. It is charged with insuring that prescribed technical and management procedures are followed within the maintenance complex. The staff is also responsible for functional check flight (FCF) deficiency reporting and the aircraft weight and balance program. This agency is the maintenance complex monitor for technical orders (TOs), manuals, and other technical data, and, as such, maintains the master copy of each document within the complex.

Training Management Division

Although the basic responsibility for training rests with unit commanders, the DCM has overall responsibility for maintaining a balance of skills within the complex and for insuring that all personnel receive required training. To discharge this responsibility, training management assures the existence of a viable, well-planned maintenance training program.

Management Support Functions

This division contains four consolidated sections: maintenance analysis, programs and mobility, files management, and maintenance administration.

Maintenance Squadron Commander

Maintenance squadron commanders are responsible for normal command functions and the quantity and quality of production by their personnel. Under the AFM 66-1 concept, there are four aircraft maintenance squadrons.

Organizational Maintenance Squadron (OMS)

The OMS, known as the flightline squadron, performs crew chief functions. This is the squadron that "owns" the aircraft and is responsible for the proper maintenance of aircraft records and the overall safety of activities performed on the flightline. A flightline branch is organized to control the various sections required for maintaining assigned aircraft. Each OMS has its own inspection, support equipment, base flight and transient alert maintenance branches. The inspection branch is responsible for managing periodic inspection functions. Support equipment is a subagency that inspects and maintains nonpowered equipment used on the flightline. Base flight and transient maintenance is responsible for maintaining and providing service and support for transient aircraft.

Field Maintenance Squadron (FMS)

This squadron provides specialists who maintain all aircraft systems other than avionics or munitions. Most of the shops are required to support both on-equipment and off-equipment requirements. That is, the personnel can be dispatched to the aircraft or retained in the shops to work on components. Typically each FMS has four branches. The propulsion branch is concerned with the jet and small gas turbine engines. Aerospace systems has the hydraulic, egress, electric, fuel and crash recovery specialist shops. Fabrication contains the personnel responsible for the machine shop, sheet metal, corrosion control, and nondestructive inspection (NDI) laboratory. The aerospace ground equipment (AGE) branch is responsible for repair, inspection, service, and delivery of all powered ground equipment.

Avionics Maintenance Squadron (AMS)

The organization of this squadron's personnel depends on whether the avionics systems of the aircraft are integrated. If integrated, personnel are divided into a flightline dispatch branch and an in-shop branch. If not integrated, the branches are structured by homegeneous groupings. For example, there may be branches for the communication-navigation, radar, and flight control functions. In either case, the AMS is responsible also for maintaining aircrew training devices and the precision measurement equipment laboratory (PMEL).

Munitions Maintenance Squadron (MMS)

Most MMS personnel are involved in either the munitions services or munitions maintenance and storage functions. The munitions services branch contains all load crews and is also concerned with the on-and off-equipment maintenance and storage. The agency is responsible for the receipt, inspection, maintenance, delivery, and disposal of assigned munitions and storage facilities. MMS also may have an explosive ordnance disposal (EOD) agency.

Base-Level Centralized Supply Organization (16:10-16)

The Chief of Supply complex is composed of four sections. Each section is further divided into units and sub-units, and is responsible for specific areas of the supply system. These responsibilities are outlined in the following paragraphs.

Chief of Supply (COS)

The COS is responsible:

1. To command a wide array of procedures to provide the required materials in support of base requirements.
2. To maintain close liason with all base and tenant organizations, providing both technical assistance and guidance on supply matters.

Management and Systems Section (DMSP)

This section is the overall controlling function within supply, acting as the supply organization's "eyes and ears".

a. Procedures and Analysis

This unit ensures that the other sections/units of Supply follow prescribed procedures by way of constant internal surveillance programs. They also develop necessary supplements to supply and supply related manuals and regulations. Through statistical trend analysis, this unit provides the supply commander and section chiefs with the capability to identify deficiencies within the supply account.

b. Funds Management

This unit is the central point for the distribution and management of supply and equipment funds. It acts as a liaison between Accounting and Finance, and supported activities for fund requirements. This unit assembles and compiles budget and financial plans for supplies and equipment, and performs continuous analysis of prepared financial management reports.

c. Customer Service and Training

This unit conducts and monitors training within the Chief of Supply complex and provides a continuous customer training program. Additionally, this unit is the single point of contact for customer assistance. All guestions, problems, and complaints are handled by this unit.

d. Inventory

This unit is responsible for inventorying all items. This includes both complete and special inventories of supplies and equipment. This unit establishes inventory schedules, researches inventory discrepancies, and makes adjustments to the inventory records when necessary.

e. Document Control

This unit is reponsible for ensuring the timely and accurate processing of all supply documents. The unit maintains document and report files to support accountibility of assets assigned to the Chief of Supply.

f. Computer Operations

This unit physically operates the Remote Processing Station (RPS), provides keypunch support to the supply account, and readies computer products and reports for distribution within supply and to support organizations. The actual supply computer is the central base computer, used by all activities on base.

g. Administrative

This unit routes incoming and outgoing correspondence for the Supply Complex.

Operation Support Section (DMSC)

The DMSC is responsible for the effective and efficient management of functions involved in direct customer support. Functional personnel within this Section conduct customer assistance visits as directed by the Chief of Supply.

a. Demand Processing

This unit serves as the primary point of submission and preparation of requests for issue of supply items. They maintain listings and are responsible for controlling indicative data for internal records. They also maintain a comprehensive library of research and technical publications used in item identification.

b. Repair Cycle Support

This unit controls and monitors the repair cycle or Due-In-From-Maintenance (DIFM) program. They also manage critical items.

c. Mission Support

This unit is responsible for controlling and requisitioning all Mission Capability (MICAP) requirements including timely reporting procedures. This unit establishes procedures for coordination and verification of MICAP data between base supply and maintenance activities to ensure validity.

d. WRSK/BLSS Management

This unit is responsible for the receipt, storage, and issue of War Readiness Spares Kit (WRSK)/Base Level Self-Sufficiency Spares (BLSS)/Mission Support Kit (MSK) items.

e. Operations Support

This unit is responsible for operating decentralized supply support sub-units within customer organizations. They serve as a "mini-supply" whose duties include functions similar to Demand Processing, Mission Support, Repair Cycle, etc. In the Tactical Air Forces, it also manages the demand processing and WRSK/BLSS Units.

Material Management Section (DMSM)

This section is responsible for the effective and efficient management of all items included in the supply and equipment accounts.

a. Stock Control

This unit keeps the Material Management Officer (MMO) informed on management data relative to the effectiveness and efficiency of the operation, and on unusual circumstances or trends in stock control. Stock control is vital to an effective account. Their activities ensure the timely order, receipt and processing of stock to meet customer demands.

b. Equipment Management

This unit is responsible for processing and maintaining equipment allowance and authorization documents, computing equipment requirements, and serving as the point of contact for all equipment demands placed upon the Base-Level Supply System.

c. Retail Sales

This unit is responsible for direct sales or issue of individual equipment, tools, and expendable administrative janitorial type supplies to satisfy customer requirements.

d. Mobility

This unit is responsible for all functions involved in the management of mobility bags and small arms including build-up, accounting, storing, reporting, issuing, etc.

e. Munitions Management

This unit is responsible for all functions involving inventory, accounting, and storage of munitions. They must ensure that proper physical inventory control, secure storage, and authorized use of ammunition are constantly maintained.

Material Storage and Distribution Section (DMSD)

This section is responsible for the proper receipt, inspection, issue, storage, warehousing, materiel handling techniques, pick-up and delivery, and related operational procedures pertaining to the processing, care, and protection of all supplies and equipment for which the supply complex has storage responsibilities. They also provide technical assistance to the other supply complex storage activities, maintaining diagrams of the storage area showing the layout, etc.

a. Inspection

This unit determines the condition, security, classification, status and identification of supplies and equipment.

b. Receiving

This unit receives supplies and equipment which are shipped from sources of supply or returned to base supply by customers.

c. Delivery and Pick-up

This unit uses appropriate vehicles to deliver and pick-up property from base supply customers.

d. Storage and Issue

This unit provides for secure storage of items in stock (in the warehouse). They also select items when they are requested by customers for issue.

e. Bench Stock Support

This unit is responsible for establishing bench stocks in coordination with supported activities. They review, replenish, deliver, and bin bench stock items for all on-base maintenance activities.

APPENDIX B

THE TUAF REQUIREMENTS AND DISTRIBUTION PROGRAM

Development and implementation of the Requirements and Distribution System (RDS) was recommended by the United States Air Force (USAF) to improve the current supply system, improve supply effectiveness and reduce parts shortages.

In this appendix, general characteristics, functional areas, constraints, proposed methods and procedures, life cycle, users, and models of the RDS are reviewed.

General Characteristics of the RDS

According to the "RDS Functional Description" report (19:2-2,2-3), the RDS will have the following general characteristics:

"a. Be compatible with the remainder of the TUAF logistics system.

b. Use modern information and automation techniques where appropriate.

c. Be capable of interfacing with the USAF Cataloging

Data System.

d. Provide for alternate contingency operations to allow continued support where access to the host system is denied.

e. Provide for controlled access and use of selected information.

f. Provide the capability to satisfy logistics needs in accordance with mission priorities.

g. Be responsive to fluctuations in requirements caused by addition or deletion of weapon and support systems to the TUAF forces, program changes, or modifications."

Functional Areas of the RDS

In the same report (19:2-3,2-4), functional areas of the RDS are outlined below:

a. "Identify Items: To provide a centralized record of item modification data for all items stocked, stored and issued by the TUAF RDS, to maintain currency of identification data, to provide rapid visibility of this information, and to provide an interface with the USAF Stock Number User Directory (SNUD)."

b. "Compute Requirements: To determine the ongoing replenishment need for spare parts using an automated forecasting technique and to compute the buy, repair, termination, disposal and replenishment budget requirements for all centrally managed reparable, nonreparable and equipment type items."

c. "Manage Funds: To record budget requirements, provide visibility and accounting for funds expended, and provide financial management reports in support of the RDS."

d. "Distribute and Manage Stock: To provide centralized records on the acquisition, repair and disposal of material, to manage the distribution and redistribution of base/depot assets, and to monitor the administration of stock that accounts for receipt, storage and release of assets including appropriate inspection and inventory."

Constraints of the RDS

Constraints of the RDS system are given as:

a. "The RDS is a stock number oriented system. Only those items having a valid stock number and associated catalog management data recognized by the RDS will be processed by the system. Duplicate National Item Identification Numbers (NIINs) are not permitted."

b. "Management practices and policies and human decision making processes reside outside the scope of the RDS. The RDS can only be used for peace time reguirements."

c. "There is no limit to the different types of items that can be put into the RDS as long as they are assigned a stock number identification and certain minimum catalog management data. The types of items can range from replenishment spares for weapon/support systems to ammunition, petroleum, oil, lubrication, medical, vehicle, photographic, etc. However, the basic logic contained in the RDS is geared towards replenishment spares capability for weapon/support systems."

Further limitations designed into the RDS are itemized in the following discussion for each functional subsystem:

a."Identify Item Subsystem

(1) Mechanical interface with other country cataloging programs will be limited to the SNUD at the U.S. Air Force Logistics Centers (AFLC) and secondary Defense Logistics Supply Centers interrogation capability.

(2) No technical item description file (drawings, form, fit and function data, etc.)."

b."Compute Requirements Subsystem

(1) No initial provisioning capability.

(2) No mechanical assignment of actual pipeline data for individual stock numbers.

(3) No computation of local purchase/local manufacture requirements.

(4) No tracking of equipment items by system application.

(5) No computation of base level repair requirements."

c."Manage Funds Subsystem

(1) No cost accounting for depot/factory maintenance.

(2) No expense accumulation for labor and overhead.

(3) No budgeting for depot/factory maintenance.

(4) No paying and collecting funds."

d."<u>Distribute and Manage Stock Subsystem</u>

(1) No asset balances by bin location.

(2) No assignment of empty bin locations.

(3) No base local purchase or local manufacture subsystem.

(4) No bench stock or other maintenance nonreparable item stock control and visibility.

(5) No Precision Measurement Equipment Laboratory (PMEL) logic.

(6) No configuration control for installed assets.

(7) No warehousing or transportation logic, except where it interfaces with the RDS.

(8) No part number management system."

<u>Proposed Methods And Procedures</u>

In the same report (19:2-10,2-12), proposed methods and procedures were explained as below:

"An automated RDS for the TUAF is being defined to operate within a centralized interactive data management architecture with the following characteristics:

-Host computer linked to base, depot and remote site terminals (CRT display and remote printers).

-Central current source of information for all users.

-On-line transaction processing capability.

-System-wide visibility of assets and status.

-"Push distribution (stock level shortages and resupply actions automatically determined by host computer).

-Centralized monitoring of all stock administration functions (inventory, inspection, retagging, binning, backorder releases, etc.)."

The RDS Life Cycle

The RDS life cycle is defined as consisting of five phases. The phases are (a) Conceptual Phase, (b) Definition Phase, (c) Development Phase, (d) Test Phase and (e) Implementation/Operational Phase. The first two phases of the project have been accomplished. (14:1,26)

Activities in the phases are explained below.

a. Conceptual Phase

This phase's activities were accomplished as below.

-Identification of needs.

-Investigation of alternative solution.

-Provision for documentation needs.

-Preparation of procedures.

The conceptual phase was accomplished in an 18 month period. At the end of this phase, establishment of the RDS system was decided.

b. Definition Phase

During this phase, the following activities were accomplished.

-Identification of the TUAF supply system's functional areas as explained above (Identify Items, Compute Requirements, Manage Funds, Distribute and Manage Items).

-Investigation of computer effectiveness in the supply area.

-Investigation of the relationships between the supply and other logistics functional areas.

-Determination of supply system automation necessity.

The definition phase consisted of a 17 month period. In the last 10 months of this phase, activities were accomplished by a study group that included the USAF and TUAF personnel in the U.S. The TUAF personnel in the study group included 2 operations researchers and 4 supply officers.

c. Development Phase

This phase's activities can be summarized as below.

-Integration of supply functional areas.

-Determination of appropriate computer brand and preparation of computer programs.

-Preparation of the RDS user instructions.

-Acquisition of the computer system.

In this phase, 10 operations researchers and 6 supply officers from TUAF were sent to the SM/ALC in Sacramento, California. The development phase took 18 months and was completed on 1 August 1986.

d. Test Phase

This phase will take an 8 month period from 1 August 1986 to 1 April 1987. The following activities will be done during this phase:

- Pre-test of the computer system capabilities and programs, prepared in the development phase, will be tested by the TUAF personnel (with simulated data) in the U.S. between 1 August 1986 and 1 October 1986.
- Computer location areas and phone circuits will be prepared by 1 February 1987 in Turkey. Also on the job training and computer system set up will be done in the same period.
- Between 1 February 1987 and 1 April 1987, the pre-implementation test will be done in Turkey using real data. This test will consist of computer programming, computer system capability assessment and the RDS user instruction tests.

e. Implementation/Operational Phase

The implementation phase will include 5 subphases to integrate all the TUAF bases and depots (9 bases and 3 depots). This phase will take 12 months, beginning 1 April 1987. Integration of the system will be done step-by-step according to base and weapon system priority. Also, during this phase, the system will be tested by the USAF and the TUAF study group as each subsystem is completed.

The RDS Users

Before the RDS, item manager and system manager concepts did not exist. Requirements determination was done by the Delphi technique with a group of experts subjectively determining stock levels based on their judgements. This technique is inefficient. Requirements determination was performed at each base and requested stock levels were sent to a central point for procurement. This led to redundancy in stocks because there was no item visibility.

In the RDS, every level of supply and maintenance (base and depot levels) has visibility. Because of this advantage, maintenance managers in the base or depot levels determine their needs and can prepare their maintenance programs more realistically. Also supply managers (in the base or depot) can control their stock levels more effectively. They can give more attention to provide the local purchase items because all centralized purchase item stock levels will be determined by the central host computer and provided to the item managers.

Under the new system, all supply activities, except local purchase in the operating base and depot levels will be centrally executed and controled by the TUAF Logistics Command. Real users of the RDS system will be the item and system managers, assigned to the TUAF Logistics Command Headquarters, because of the centralized characteristic of the system. Item manager functions are summarized below:(14:16,17)

- -Centrally controlling and executing the supply functions for all TUAF supply items.
- -Programming and budgeting the reparable parts needs.
- -Controlling and determining the spare parts needs.
- -Controlling depot and the base stock levels.
- -Transfering items from one base to another.
- -Estimating demand levels quarterly.
- -Collecting the historical data about the item and applying the statistical results to the future program.
- -Determining the item disposablity.

The RDS will help the item manager to achive the above functions by creating the data listed below:

- -It estimates the demand levels for the centralized purchase items according to the poisson distribution.
- -It provides each depot and base stock level seperately.
- -It distributes all depot and base needs automatically.
- -It provides current budget knowledge.
- -It provides search capability to the item manager when a backorder occurs. To eliminate the backorder, the item manager can transfer the items from one base to another by sending a release output notice.
- -If the item manager decides the estimated demand will not meet future needs, he can adjust the estimated demand based on his subjective decision, overriding the

computer generated stock level.

The RDS Models

The descriptive model is intended as a close approximation of the actual decision-making environment, which can be used to evaluate alternative courses of action supplied by the decision maker. On the other hand, the normative model is a more abstract mathematical representation of the decision-making environment.(1)

From the RDS Functional Description report (19:2-5,2-103), the following knowledge about the RDS models can be summarized.

The RDS consists of analytical stock control models depending on the item classification (EOQ model for disposable, pipeline model for reparable and backorder model for equipment). The forecasting model depends on the historical data, the poisson distribution and a set of management reports.

The COBOL language is used to write the programs.

Reports are generated and automatically displayed at regular periods (quarterly for all items or daily when requested by the item manager or other user for a specific stock number).

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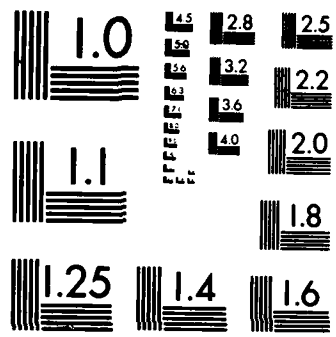

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APPENDIX C

THE USAF COMBAT ORIENTED MAINTENANCE ORGANIZATION (12:13-14)

Background

MCR 66-5 is an outgrowth of one of the maintenance posture improvement program (MPIP) initiatives. The specific initiative was the combat-oriented maintenance organization (COMO) concept, and MCR 66-5 still carries this title. The stated objective was to increase sortie production capability. This was to be done by assigning on-equipment technicians to the flightline squadron; cross-training them in the highly repetitive flightline task; organizing them into aircraft maintenance units (AMUs) for mobility affiliation with the tactical squadrons; and placing the bulk of the production responsibility on the AMU supervisors. These actions were to expand total work force flexibility, simplify specialist dispatch, and decentralize production decisions to improve sortie capability.

The assignment of specialist to the flightline squadrons resulted in a major realignment of the previous AFM 66-1 squadron functions and responsibilities. Foremost was a reduction of one maintenance squadron without changing the deputy chief for maintenance's staff organization.

Aircraft Generation Squadron (AGS):

AGS took the old flight branch of crew chiefs and added the flightline specialists from FMS and AMS and the load crews and on-equipment weapons release and gun services specialist from MMS. The total assigned personnel are allocated among the AMUs;-the number is determined by the numbers of aircraft and tactical fighter squadrons. The AMUs are aligned with the fighter squadrons by unit designation, patches, and flying schedules when possible. A large support branch serves as the focal point for the consolidation of equipment, parts, and vehicle support.

Component Repair Squadron (CRS):

This squadron repairs avionics and aircraft systems components, operates metal fabrication activities, and performs in-shop repair of jet engines and aircrew training devices and PMEL functions.

Equipment Maintenance Squadron (EMS):

This squadron is responsible for AGE and all munitions activities except those transfered to the AGS. Also it is responsible for aircraft inspection, fuel and egress systems, and base flight and transient aircraft.

APPENDIX D

SUMMARY OF TSAR CAPABILITIES (6:1-11)

TSAR simulates a system of interdependent theater airbases, supported by shipments from CONUS and by intratheater transportation, communication, and resource management systems. By capturing the interdependencies among 11 classes of resouces, the simulation will permit decisionmakers to examine the implications of many possible improvements in terms of their effects upon the sortie generation capabilities of a system of airbases. The simulation also allows examination of the effects of damage inflicted by enemy airbase attacks using both conventional and chemical weapons, and the result of efforts to restore operations.

The classes of resources treated in TSAR are (1) aircraft, (2) aircrews, (3) ground personnel, (4) support equipment (AGE), (5) aircraft parts, (6) aircraft shelters, (7) munitions, (8) TRAP, (9) POL, (10) building materials, and (11) airbase facilities. Many different types of each class of resource may be distinguished. When parts are included in the simulation, initial stocks may be specified, or TSAR will initialize the parts data according to standard algorithms for POS, BLSS, and WRSK, and will also initialize the stock location in the depot pipeline.

TSAR is a Monte Carlo discrete-event simulation model that analyzes the interrelations among available resources and the capability of the airbases to generate aircraft sorties in a dynamic, rapidly evolving wartime environment. On-equipment maintenance tasks, parts and equipment repair jobs, munitions assembly, and facilities repair tasks are simulated at each of several airbases. If desired, the constraints imposed by wearing individual chemical protection equipment (IPE) during the conduct of these activities may be simulated. A broad range of policy options that would increase initial resources, modify maintenance doctrine, or improve theater resource management may be assesed using TSAR. Provisions also are included that provide the user a capability to assess dynamic variations in key management policies.

TSAR is readily adaptable to initial conditions encompassing a broad range of complexity. When specific features are not needed for the examination of a particular issue, they simply need not be used. Thus, TSAR permits one to represent either a single base or a set of independent airbases without any adjustment or modification of the program. Similarly, the user may not wish to examine the effects of airbase attacks using conventional or chemical weapons or may wish to ignore the possible restraints imposed by shortages of aircrews, shelters ground personnel, equipment, aircraft parts, munitions, TRAP, and/or fuel. He may also consider or ignore the special problems associated with the air traffic control constraints on flight operations and with operations in a chemical environment. TSAR adapts automatically to all such problem representations.

TSAR provides potential users a means by which a rich variety of potential improvements for theater airbases may be tested in a common context. By comparing how such improvements affect the system's capabilities for generating effective combat sorties, TSAR can assess new passive defenses, new maintenance doctrine, modified manning levels, enhanced cross-training, improved clothing and facilities for chemical protection, improved procedures and equipment for increasing runway utilization, increased stock levels for parts and equipment, and many others, as well as several concepts for theater-wide resource management. TSAR has also provided an effective context for assessing new weapon concepts and improved reliability and maintainability of prospective aircraft (ATF) designs.

An important objective in the original design formulation was to achive a sufficiently high speed of operation that the extensive (often trial and error) sequence of runs so frequently necessary in research and analysis would be economically practical. Adaptation of existing models (e.g., LCOM, SAMSOM) was rejected because modifications would have been extensive and execution times prohibitive for problems of the size that were contemplated. The TSAR program is written in the widely available FORTRAN language. It achieves a substantially higher speed by virtue of more efficient processing and by taking advantage of core storage increases of modern computers. In its current formulation, TSAR makes no intermediate use of auxiliary high-speed storage units (e.g., disk, tapes) expect the TSARINA assessments of air attacks and the initial conditions for multiple trials.

In TSAR, several types of aircraft can be assigned to each airbase. The aircraft of a given type at any airbase may be supported by a common pool of resources (personnel and equipment), or, as in the COMO concept, the aircraft may be organized into two or three subgroups (squadrons) each supported by its own set of resources (AMU--aircraft maintenance unit). The aircraft are lunched on sorties in response to a set of user-supplied sortie demands differentiated by base, aircraft type, mission and priority; if a base is not specified, the sortie demands are allocated to the base best able to generate the necessary sorties. Flights may be scheduled, or they may be scrambled on demand using aircraft that have been placed on alert. Aircraft may be lunched late, when permitted, or they may ground abort, and flights may be cancelled if required by air traffic control constraints.

When launched, aircraft may air abort or may be lost on a combat mission; when an aircraft returns it may be damaged, require decontamination, still have munitions, be due for phased (periodic) maintenance, and have several unscheduled maintenance task requirements. These maintenance task are normally done at the aircraft's operating base, but an aircraft may be ferried to a rear base for certain specified maintenance tasks. When aircraft are lost, a replacement may be ordered from CONUS, or if aircraft are set aside in the theater as fillers, they provide rapid replacements for lost aircraft and, if specified, for aircraft ferried to the rear for maintenance. When filler aircraft are used to replace losses, a replacement for the filler force is ordered from CONUS, if such resources are available.

When an airbase runway has been closed because of an airbase attack, aircraft scheduled to land are diverted to other bases, preferably to one that normally operates the same type of aircraft. If sortie generation capabilities are assessed daily (an option), the base best able to support the aircraft is selected. During the period that runway remains closed, that airbase's sortie demands can be allocated to functioning airbases with the appropriate type of aircraft in proportion to either the aircraft available or, if base capabilities are assessed daily, the bases' sortie generation capabilities. When a runway has been reopened, that bases' aircraft recover at their parent base on completion of their next combat sortie, if base sortie-generation capabilities are not assessed, or, if they are, when their parent base's sortie-generation capability per available aircraft is within a specified percentage of that at the temporary base.

When an aircraft lands it may be refueled at a hot-pit hydrant. Each aircraft is assigned to an aircraft shelter if one is available; if not, it is parked on one or another of the designated ramps. Chemical decontamination of the aircraft is scheduled if required. The next mission assignment for each aircraft is selected tentatively when the aircraft lands; that selection takes into account the known demand on that base to meet for sorties and the projected capability of that aircraft at that base to meet those demands. The selection also takes into account which of that aircaft's unscheduled maintenance task would need to be accomplished for the different mission and when that particular aircraft could probably be readied for the different missions. All tasks that are not essential for the tentative mission assignment may be deferred and the available resources concentrated on required tasks. If aircraft are eventually found not to be needed for the mission for which they were readied, they are reassigned and reconfigured for more appropriate mission. If phase maintenance is to be simulated, it may be deferred during specific times during the scenario and will be done at night when not deferred.

On-equipment maintenance task may require several people, specialized equipment, and spare parts; each task is either a single set of such requirements--i.e., a simple task--or a network of tasks, each with its own demand for personnel, equipment and parts. When resources are limited, those aircraft most likely to be readied first (given sufficient resources) may be given priority. The basic input data that govern the probabilities for unscheduled maintenance tasks (other than battle damage repairs) may be used directly for the simulation or varied statistically to reflect unexpected differences between planned levels and "actual" wartime experience. Furthermore these task probabilities--i.e., the break rates--may either have a fixed rate or be varied daily by shop and aircraft type as a function of achieved sortie rate or other user-specified adjustments.

If a required part is not available, (1) the broken one that is removed may be repaired on base, (2) the part may be cannibalized from another aircraft, (3) a part may be obtained by lateral resupply from a specified subset of bases, or (4) the part may be ordered from a central source within the theater. When a part is cannibalized, it may itself be broken. When a part can not be repaired on base (is NRTS) it may be sent to a neighboring base or to a centralized facility in the theater designated to perform intermediate maintenance--i.e., a CIRF. When parts can not be repaired within the theater, the user may request a replacement from depots in the CONUS. Parts may either be a simple part or an LRU that has a defective SRU. Simple parts may be repaired on base using either a unique procedure or a procedure selected at random from two or more repair procedures. For LRUs, the resource requirements to diagnose and replace the faulty SRU are specified separately for each SRU. Faulty SRUs withdrawn from an LRU may themselves be repaired on base or NRTSed to another location for repair.

The various types of support equipment used in on-equipment and off-equipment jobs, in munitions assembly and loading tasks, and by base civil engineers are themselves subject to malfunction and repair. Equipment repair may follow a specific procedures selected at random. The special complexities of full or partial mission capability of AIS test equipment used to repair LRUs and SRUs for late-model aircraft may also be simulated.

Each maintenance task, parts repair job, and equipment is associated with a particular work center or shop. The user may group the resources and tasks into up to 25 different "shops", exclusive of those associated with the scheduled preflight maintenance tasks. Because each shop may be assigned several different types of personnel and equipment, those engaged in on-equipment and off-equipment tasks may be the same or different depending upon how the user wishes to define the base's maintenance policies.

The user is given substantial flexibility in defining the rules by which aircaft maintenance tasks are processed. He may permit the activities of certain groups of shops to proceed simultaneously or may require that the activities of several such groups of shops proceed in a specified order. He also may control these prescriptions for simultaneous and squential operations separately for each aircraft type at each base. Furthermore, for those groups of shops that are permitted to proceed simultaneously, certain exceptions may be specified in the form of lists of activities that are incompatible with each particular task. These futures permit alternative maintenance operating doctrines to be simulated and to be examined for their influence on sortie generation capabilities. Work speed-up and other procedures to shorten on-equipment, preflight, and off-equipment activities also may be specified.

Scheduled preflight tasks are also associated with the shop structure. These tasks involve aircraft refueling and the loading of both basic defensive munitions and mission-dependent munitions. The likelihood that the basic munitions and the mission-dependent munitions are retained from the previous sortie can be specified independently for the two classes of munitions. After mission assignment, aircraft configuration is checked and, if necessary, the aircraft is reconfigured; this may involve one or two separate tasks, each of which may require TRAP, personnel, and equipment. The loading of the mission-dependent munitions also may involve one or two separate tasks, each with its distinct requirements.

When munitions assembly tasks are simulated, munitions demands are projected periodically to define which types of munitions need to be assembled. Such jobs may require both personnel and equipment, much like other tasks that are simulated in TSAR, as well as components from which the simulation are to be assembled. When munitions assembly is simulated, initial stocks and components, as well as shipments, are distinguished as to whether the munitions are assembled.

Chemical protective clothing may be required to be worn at all times for any or all tasks, whether or not a chemical attack has occured, or only when required by the chemical environment. The increased task times that result from restrictions on mobility, visibility, dexterity, and communication and the buildup of excessive body temperature because of the poor heat-transfer properties of such clothing may be defined uniquely for each task. If the work crew temperatures rise too high, the crew suffers heat exhaustion and must be hospitalized; if they do not collapse, they may have to wait until they have cooled down to a specified level.

Several features permit the user to simulate various workaround procedures that can alleviate resource constraints. One such feature permits the user to specify alternative resource requirements for any on-equipment task, part repair job, weapons assembly task, or civil engineering job. For example, one might specify that a three-man crew could do a normal four-man job in 50 percent more time. Similarly, when TRAP or munitions shortages do not permit the normal or preferred munitions to be loaded for a mission, alternative loadings may be specified. A third workaround feature permits the user to designate that certain types of personnel have been cross-trained and that they may replace or assist certain other specialists. This personnel substitutability feature is operative only at specified bases and only for those on-equipment tasks, munitions assembly tasks, and civil engineering jobs that have been specified.

The effects of damage and chemical contamination due to airbase attacks may be simulated. Input data generated by TSARINA normally define the time and location of the attacks, the damage to individual aircraft shelters and other facilities, the contamination at different locations, the damage to runways and taxiways, and the percentage of conventional damage suffered by the personnel, equipment, parts, munitions, TRAP, and POL at each facility. (Only simple conventional attacks can be defined for TSAR without using the TSARINA airbase damage assessment model.) When aircraft or facilities sustain conventional damage, some portion of the personnel, equipment, and parts at these locations also may be lost. Damage to runways and taxiways may interrupt flight opeartions, and damage to other key facilities can degrade air traffic control performance. Following a chemical attack, the likelihood that personnel sustain an incapacitating or lethal dose is based on the warning time for the attack, the arrival time of the chemical contaminants, and the degree of personnel protection. Aircraft are assigned a specific shelter when they land, but the aircraft may be partially exposed when certain shop operations are underway at the time of airbase attack. Alert aircraft may be given priority for assignment to a specific set of shelters, and the damage to these aircraft may be distinguished from that for other aircraft. Aircraft in excess of those that may be placed in shelters, are assumed to be parked on designated parking ramps and to sustain a loss rate appropriate for that ramp. TSAR decrements the various resources to the extent implied by the damage and chemical casualty data. If personnel have generated excessive heat because of their chemical protective clothing, they are required to rest until their temperatures have fallen to the specified level. If personnel sustain casualties other personnel may be required to provide buddy care for a specified time, to simulate helping the casualties obtain medical assistance. After user-stipulated delays, to roughly account for the disruptive effects of the attack, personnel resume their activities unless a specific facility is required and has been damaged--these delays can be varied in relation to the strength and extent of the attack.

Replacement resources (aircraft, pilots, personnel, parts, munitions, TRAP, and building materials) may be ordered from CONUS when losses are sustained. Resources available for replacing losses may be specified, and the time required to replace the loss may be specified, independently.

After an airbase attack, civil engineering personnel, equipment, and building materials are located to repair the runway and taxiway network. The location and number of such repairs are based on the numbers of unexploded ordnance (UXO), mines, and craters from all previous attacks that have not been repaired, plus those delivered by the most recent attack. When the unexploded ordance has been removed from one subsection of the intended minimum operating surface (MOS), mine clearance may begin. When clearance has been completed on that subsection, crater repair is begun. The order in which the MOS subsection are cleared is selected for efficient utilization of the available civil engineering resources. The prioritization of taxiway repairs is designed to maximize the rate at which undamaged shelters obtain access to the selection of runway that is being repaired. When the MOS has been cleared, the user may specify that the MOS should be extended, that the entire surface should be cleared, or that the main runway should be cleared when the MOS is on a secondary runway--several extended clearance options are available. Resources to repair the other facilities are allocated according to a priority specified by the user. Operation of these facilities is resumed when they once again are functional.

In addition to simulating a set of airbases, the user also may specify the existence of a theater reserve of filler aircraft, a centralized theater distribution center, or a centralized theater repair facility at which some or all intermediate maintenance is conducted. At the user's options, the filler aircraft can be used to replace aircraft losses and aircraft that have been withdrawn to a rear base for maintenance. When additional aircraft resources are specifed as available in CONUS, they supplement the filler force. The filler aircraft are managed so as to maintain the inventories at the operating bases.

The centralized theater distribution facility can receive spare parts from CONUS and either retain them until demanded by a base or transship (some or all) to the base with the earliest projected requirement. Such a facility can also be used to direct the lateral shipment of parts and other resources from one base to another. A theater parts repair facility, sometimes refered to as a CIRF, is assigned maintenance personnel, equipment, and spare parts (LRUs and SRUs). Parts are shipped to and from the CIRF from the operating bases and are processed in the manner prescribed by the user's choice of which theater management rules are to govern these operations.

The simplest rules for CIRF operation prescribe that faulty parts are repaired in the order in which they arrive and that they are returned to the sender. The user may also invoke a variety of more complex theater management algorithms, not only for selecting what to repair and how to dispose of parts when they have been repaired but for reallocating personnel, equipment, and parts among the several operating bases. Repair priorities can be based on existing and projected demands and on the relative necessity of parts for the various missions. Shipment priorities are related to the current and projected demands, base reparables, and enroute serviceables. When central stocks are insufficient to meet a base's demand, another base can be directed to ship the required part, if both the requesting base and the donor base meet certain conditions relative to the importance of the demand and the availibility of stock.

Daily estimates can be prepared (an option) of each base's capabilities for generating different kinds of missions with different types of aircraft. These estimates provide the basis for various aircraft management decisions. One application is in selecting which base is to be assigned the sortie demands for which no base has been specified. These data can also be used for assignment decisions when aircraft must be diverted and when they are transferred from base to base to balance maintenance workloads.

The theater-wide management of the various resources is supported by a user-specified schedule transportation system that may be subjected to delays, cancelations, and losses. TSAR also permits the user to represent a theater-wide reporting system that can be used to provide the central management authority with periodic resource status reports from the several operating bases; these reports may be delayed, incomplete, or lost.

When these transportation and communication systems are coupled with the sets of rules for distributing and redistributing resources among the operating bases, various concepts of theater resource management may be represented and examined in the context of realistic transportation and communication imperfections. In its current formulation, TSAR already includes certain alternatives for the theater management rules that have been designed to permit additions or modifications to be readily accommodated.

TSAR (and companion TSARINA model) naturally have limitations and ommissions that will inconvenience some potential users. The more obvious limitations derive from the manner in which the problem was bounded in designing TSAR. Some users will be bothered that TSAR treats friendly sorties simply as delays during which the aircraft are not present at an airbase; others will wish that active airbase defenses had been included as an integral part of the simulation, rather than being required to consider active defense tradeoffs externally to TSAR/TSARINA analysis--and still others will find that these tools would be more useful if the production-oriented batch processing of spare parts, as they are handled at depots, also was modeled.

Each of these design limitations could be a serious obstacle for some potential users, but none of these bounds was chosen casually or accidentally. All problems must be bounded, and we believe the choice of boundries need not inhibit many useful and important analyses. Furthermore, it would be conceptually fairly easy to substantially extend or eliminate these boundries because TSAR's data structure is sufficiently detailed to be compatible with many such additions. But most such additions would entail difficult design and programming efforts and would further increase TSAR's execution time and expand its input data collection problems.

The last of the limitations that should be highlighted is TSAR's data input requirements. As one elects to include more and more of the real world considerations that TSAR permits the user to include, these requirements become substantial. That is not a property of TSAR but of the richness of the user's problem definition--any approach to dealing with his problem at a comparable level of detail would require equivilent information. TSAR's main contribution to this dilemma is that it will function comfortably at many levels of detail, and the user may quite simply select or reject most of its features and the related data requirements. One important benefit of this flexibility is that analsyts can test the potential sensitivity of their results for a particular effect for which the data would be difficult or costly to secure, using invented data that spans a reasonable range of uncertainity. If his results are reasonably insensitive to that varition, he has an argument for neglecting the effect--if they are sensitive, he has an argument for mounting the effort to secure the needed data.

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ABSTRACT

This study investigates three base-level logistics order and information models to show their effects on logistics system performance. The selected models are the current TUAF manual system, the planned TUAF RDS and the current USAF COMO/COSO order and information models. The first two models represent a centralized logistics management policy. The third model, USAF's COMO/COSO, represents a more decentralized logistics management policy using a computerized order and information procedure. To compare the performance of these three models, the TSAR (Theater Simulation of Airbase Resources) program was used. Input data was obtained from an F-16 TSAR Data Base documented by Orlando Technology, Inc. of Orlando Florida. Outputs of the three models are analyzed by comparing the flown sortie rate, number of non mission capable (NMC) aircraft, NMC hours, and number of holes for a given scheduled sortie rate, stock level, and number of aircraft.

The results of this study indicate that the USAF COMO/COSO order and information model policy gives the highest number of NMC aircraft and holes, and NMC hours for given order and ship time. However, the lowest NMC hours per hole resulted from this model. The results also indicated that the TUAF manual order and information model is the least desirable because it provides the lowest sortie rate. It also yields the lowest number of NMC aircraft, and holes, and NMC hours for given order and ship time. However, it provides the highest NMC hours per hole.

The major limitations of this study are: (1) Approximated order and ship times, (2) Hypothetical information about the TUAF Logistics policy, procedures, and organizational functions.

This study should only be used as a reference for a further study that utilizes real data, and as a convenient reference for discussion of logistics system's base-level order and information policies.

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